REPORT #
RRTAC 87-10

Soil Survey of the Plains Hydrology and Reclamation Project – Battle River Project Area

Heritage Fund

Alberta

LAND CONSERVATION AND
RECLAMATION COUNCIL
Reclamation Research
Technical Advisory Committee

Report No. RRTAC 87-10

SOIL SURVEY OF THE PLAINS HYDROLOGY AND RECLAMATION PROJECT - BATTLE RIVER PROJECT AREA

by

T.M. MACYK
A.H. MACLEAN

Terrain Sciences Department
Alberta Research Council

Prepared for

The Reclamation Research Technical Advisory Committee

of

THE LAND CONSERVATION AND RECLAMATION COUNCIL

1987

STATEMENT OF OBJECTIVE

The recommendations and conclusions in this report are those of the authors and not those of the Alberta Government or its representatives.

This report is intended to provide Government and Industry staff with up-to-date technical information to assist in the development of guidelines and operating procedures. The report is also available to the Public so that interested individuals similarly have access to the best available information on land reclamation topics.

ALBERTA'S RECLAMATION RESEARCH PROGRAM

The regulation of surface disturbances in Alberta is the responsibility of the Land Conservation and Reclamation Council. The Council executive consists of a Chairman from the Department of the Environment and two Deputy Chairmen from the Department of Forestry, Lands & Wildlife. Among other functions, the Council oversees programs for reclamation of abandoned disturbances and reclamation research. The reclamation research program was established to provide answers to the many practical questions which arise in reclamation. Funds for implementing both the operational and research programs are drawn from Alberta's Heritage Savings Trust Fund.

To assist in technical matters related to the development and administration of the research program, the Council appointed the Reclamation Research Technical Advisory Committee (RRTAC). The Committee first met in March 1978 and consists of eight members representing the Alberta Departments of Agriculture, Energy, Forestry, Lands & Wildlife, Environment and the Alberta Research Council. The Committee meets regularly to update research priorities, review solicited and unsolicited research proposals, arrange workshops and otherwise act as a referral and coordinating body for Reclamation Research.

Additional information on the Reclamation Research Program may be obtained by contacting:

Dr. G.A. Singleton, Chairman
Reclamation Research Technical Advisory Committee
Alberta Environment
14th Floor, Standard Life Centre
10405 Jasper Avenue
Edmonton, Alberta T5J 3N4

(403) 427-5815

This report may be cited as:

Macyk, T. and A.H. Maclean. 1987. Soil Survey of the Plains Hydrology and Reclamation Project - Battle River Project Area. Alberta Land Conservation and Reclamation Council Report #RRTAC 87-10. 62 pp.

Additional copies may be obtained from:

Publication Services
Queen's Printer
11510 Kingsway Avenue
Edmonton, Alberta T5G 2Y5

RECLAMATION RESEARCH REPORT

** 1. RRTAC 80-3: The Role of Organic Compounds in Salinization of Plains Coal Mining Sites. N.S.C. Cameron et al. 46 pp.

DESCRIPTION: This is a literature review of the chemistry of sodic mine spoil and the changes expected to occur in groundwater.

** 2. RRTAC 80-4: Proceedings: Workshop on Reconstruction of Forest Soils in Reclamation. P.F. Ziemkiewicz, S.K. Takyi, and H.F. Regier. 160 pp.

DESCRIPTION: Experts in the field of forestry and forest soils report on research relevant to forest soil reconstruction and discuss the most effective means of restoring forestry capability of mined lands.

** 3. RRTAC 80-5: Manual of Plant Species Suitability for Reclamation in Alberta. 2 vols. L.E. Watson, R.W. Parker, and P.F. Polster. 541 pp.

DESCRIPTION: Forty-three grass, fourteen forb, and thirty-four shrub and tree species are assessed in terms of their fitness for use in Reclamation. Range maps, growth habitat, propagation, tolerance, and availability information are provided.

N/A 4. RRTAC 81-2: 1980 Survey of Reclamation Activities in Alberta. D.G. Walker and R.L. Rothwell. 76 pp.

DESCRIPTION: This survey is an update of the original report conducted in 1976 on reclamation activities in Alberta, and includes research and operational reclamation, locations, personnel, etc.

N/A 5. RRTAC 81-3: Proceedings: Workshop on Coal Ash and Reclamation. P.F. Ziemkiewicz, R. Stien, R. Leitch, and G. Lutwick. 253 pp.

DESCRIPTION: Presents nine technical papers on the chemical, physical and engineering properties of Alberta fly and bottom ashes, revegetation of ash disposal sites and use of ash as a soil amendment. Workshop discussions and summaries are also included.

N/A 6. RRTAC 82-1: Land Surface Reclamation: An International Bibliography. 2 vols. H.P. Sims and C.B. Powter. 292 pp.

DESCRIPTION: Literature to 1980 pertinent to reclamation in Alberta is listed in Vol. 1 and is also on the University of Alberta computing system. Vol. 2 comprises the keyword index and computer access manual.

N/A 7. RRTAC 82-2: A Bibliography of Baseline Studies in Alberta: Soils, Geology, Hydrology and Groundwater. C.B. Powter and H.P. Sims. 97 pp.

DESCRIPTION: This bibliography provides baseline information for persons involved in reclamation research or in the preparation of environmental impact assessments. Materials, up to date as of December 1981 are available from the Alberta Environment Library.

N/A 8. RRTAC 83-1: Soil Reconstruction Design for Reclamation of Oil Sand Tailings. Monenco Consultants Ltd. 185 pp.

DESCRIPTION: Volumes of peat and clay required to amend oil sand tailings were estimated based on existing literature. Separate soil prescriptions were made for spruce, jack pine, and herbaceous cover types. The estimates form the basis of recently initiated field trials.

N/A 9. RRTAC 83-3: Evaluation of Pipeline Reclamation Practices on Agricultural Lands in Alberta. Hardy Associates (1978) Ltd. 205 pp.

DESCRIPTION: Available information on pipeline reclamation practices was reviewed. A field survey was then conducted to determine the effects of pipe size, age, soil type, construction method, etc. on resulting crop reproduction.

N/A 10. RRTAC 83-4: Proceedings: Effects of Coal Mining on Eastern Slopes Hydrology. P.F. Ziemkiewicz. 123 pp.

DESCRIPTION: Technical papers are presented dealing with the impacts of mining on mountain watersheds, their flow characteristics and resulting water quality. Mitigative measures and priorities were also discussed.

N/A 11. RRTAC 83-5: Woody Plant Establishment and Management for Oil Sands Mine Reclamation. Technical Engineering Ltd. 124 pp.

DESCRIPTION: This is a review and analysis of information on planting stock quality, rearing site preparation, planting and procedures necessary to ensure survival of trees and shrubs in oil sand reclamation.

*** 12. RRTAC 84-1: Land Surface Reclamation: A Review of International Literature. 2 vols. H.P. Sims, C.B. Powter, and J.A. Campbell. 659 pp.

DESCRIPTION: Nearly all topics of interest to reclamation including mining methods, soil amendments, revegetation, propagation and toxic materials are reviewed in light of the international literature.

** 13. RRTAC 84-2: Propagation Study: Use of Trees and Shrubs for Oil Sand Reclamation. Techman Engineering Ltd. 58 pp.

DESCRIPTION: This report evaluates and summarizes all available published and unpublished information on large-scale propagation methods for shrubs and trees to be used in oil sand reclamation.

* 14. RRTAC 84-3: Reclamation Research Annual Report - 1983. P.F. Ziemkiewicz. 42 pp.

DESCRIPTION: This report details the Reclamation Research Program indicating priorities, descriptions of each research project, researchers, results and expenditures.

** 15. RRTAC 84-4: Soil Microbiology in Land Reclamation. 2 vols. D. Parkinson, R.M. Danielson, C. Griffiths, S. Visser, and J.C. Zak. 676 pp.

DESCRIPTION: This is a collection of five reports dealing with reestablishment of fungal decomposers and mycorrhizal symbionts in various amended spoil types.

** 16. RRTAC 85-1: Proceedings: Revegetation Methods for Alberta's Mountains and Foothills. P.F. Ziemkiewicz. 416 pp.

DESCRIPTION: Results of long-term experiments and field experience on species selection, fertilization, reforestation, topsoiling shrub propagation and establishment are presented.

* 17. RRTAC 85-2: Reclamation Research Annual Report - 1984. P.F. Ziemkiewicz. 29 pp.

DESCRIPTION: This report details the Reclamation Research Program indicating priorities, descriptions of each research project, researchers, results and expenditures.

** 18. RRTAC 86-1: A Critical Analysis of Settling Pond Design and Alternative Technologies. A. Somani. 372 pp.

DESCRIPTION: The report examines the critical issue of settling pond design and sizing and alternative technologies. An executive summary outlines the findings.

** 19. RRTAC 86-2: Characterization and Variability of Soil Reconstructed after Surface Mining in Central Alberta. T.M. Macyk. 146 pp.

DESCRIPTION: Reconstructed soils representing different materials handling and replacement techniques were characterized and variability in chemical and physical properties was assessed. The data obtained indicate that reconstructed soil properties are determined largely by parent material characteristics and further tempered by materials handling procedures. Mining tends to create a relatively homogeneous soil landscape in contrast to the mixture of diverse soils found before mining.

* 20. RRTAC 86-3: Generalized Procedures for Assessing Post-Mining Groundwater Supply Potential in the Plains of Alberta - Plains Hydrology and Reclamation Project. M.R. Trudell and S.R. Moran. 30 pp.

DESCRIPTION: In the Plains region of Alberta, the surface mining of coal generally occurs in rural, agricultural areas in which domestic water supply requirements are met almost entirely by groundwater. Consequently, an important aspect of the capability of reclaimed lands to satisfy the needs of a residential component is the post-mining availability of groundwater. This report proposes a sequence of steps or procedures to identify and characterize potential post-mining aquifers.

** 21. RRTAC 86-4: Geology of the Battle River Site: Plains Hydrology and Reclamation Project. A Maslowski-Schutze, R. Li, M. Fenton and S.R. Moran. 86 pp.

DESCRIPTION: This report summarizes the geological setting of the Battle River study site. It is designed to provide a general understanding of geological conditions adequate to establishe a framework for hydrogeological and general reclamation studies. The report is not intended to be a detailed synthesis such as would be required for mine planning purposes.

** 22. RRTAC 86-5: Chemical and Mineralogical Properties of Overburden: Plains Hydrology and Reclamation Program. A. Maslowski-Schutze. 71 pp.

DESCRIPTION: This report describes the physical and mineralogical properties of overburden materials in an effort to identify individual beds within the bedrock overburden that might be significantly different in terms of reclamation potential.

* 23. RRTAC 86-6: Post-Mining Groundwater Supply at the Battle River Site: Plains Hydrology and Reclamation Project. M.R. Trudell, G.J. Sterenberg and S.R. Moran. 49 pp.

DESCRIPTION: The report deals with the availability of water supply in or beneath cast overburden at the Battle River Mining area in east-central Alberta to support post-mining land use. Both groundwater quantity and quality are evaluated.

* 24. RRTAC 86-7: Post-Mining Groundwater Supply at the Highvale Site: Plains Hydrology and Reclamation Project. M.R. Trudell. 25 pp.

DESCRIPTION: This report evaluates the availability of water supply in or beneath cast overburden to support post-mining land use, including both quantity and quality considerations. The study area is the Highvale mining area in west-central Alberta.

* 25. RRTAC 86-8: Reclamation Research Annual Report - 1985. P.F. Ziemkiewicz. 54 pp.

DESCRIPTION: This report details the Reclamation Research Program indicating priorities, descriptions of each research project, researchers, results and expenditures.

** 26. RRTAC 86-9: Wildlife Habitat Requirements and Reclamation Techniques for the Mountains and Foothills of Alberta. J.E. Green, R.E. Salter and D.G. Walker. 285 pp.

DESCRIPTION: This report presents a review of relevant North American literature on wildlife habitats in mountain and foothills biomes, reclamation techniques, potential problems in wildlife habitat reclamation, and potential habitat assessment methodologies. Four biomes (Alpine, Subalpine, Montane, and Boreal Uplands) and 10 key wildlife species (snowshoe, hare, beaver, muskrat, elk, moose, caribou, mountain goat, bighorn sheep, spruce grouse, and white-tailed ptarmigan) are discussed.

** 27. RRTAC 87-1: Disposal of Drilling Wastes. L.A. Leskiw, E. Reinl-Dwyer, T.L. Dabrowski, B.J. Rutherford and H. Hamilton. 210 pp.

DESCRIPTION: Current drilling waste disposal practices are reviewed and criteria in Alberta guidelines are assessed. The report also identifies research needs and indicates mitigation measures. A manual included provides a decision-making flowchart to assist in selecting methods of environmentally safe waste disposal.

** 28. RRTAC 87-2: Minesoil and Landscape Reclamation of the Coal Mines in Alberta's Mountains and Foothills. A.W. Fedkenheuer, L.J. Knapik, and D.G. Walker. 174 pp.

DESCRIPTION: This report reviews current reclamation practices with regard to site and soil reconstruction and re-establishment of biological productivity. It also identifies research needs in the Mountain-Foothills area.

** 29. RRTAC 87-3: Gel and Saline Drilling Wastes in Alberta: Workshop Proceedings. D.A. Lloyd (compiler). 218 pp.

DESCRIPTION: Technical papers were presented which describe: the mud systems used and their purpose; industrial constraints; government regulations, procedures and concerns; environmental considerations in waste disposal; and toxic constituents of drilling wastes. Answers to a questionnaire distributed to participants are included in an appendix.

* 30. RRTAC 87-4: Reclamation Research Annual Report - 1986. G.A. Singleton. 50 pp.

DESCRIPTION: This report details the Reclamation Research Program indicating priorities, descriptions of each research project, researchers, results and expenditures.

RRTAC Reports 87-5 to 87-9 are in preparation.

Available from: Publication Services
Queen's Printer
11510 Kingsway Avenue
Edmonton, Alberta T5G 2Y5

* A $5.00 fee is charged for handling and postage.
** A $10.00 is charged for handling and postage.
*** A $20.00 is charged for handling and postage.
N/A Not available for purchase but available for your perusal at the Environment Library, 14th Floor, 9820 - 106 Street, Edmonton, Alberta T5K 2J6

TABLE OF CONTENTS

		Page
LIST OF TABLES		iv
LIST OF FIGURES		v
ADRIAN HENRY MACLEAN		vi
PREFACE		vii
ABSTRACT		x
ACKNOWLEDGEMENTS		xii
1.	LOCATION AND EXTENT OF THE STUDY AREA	1
2.	SOIL MAPPING PROCEDURES	3
3.	EXPLANATORY NOTE ON THE SOIL MAP AND LEGEND	5
3.1	Soil Group	5
3.2	Soil Unit	5
3.3	Dominant Soils and Significant Soils	5
3.4	Soil Map Notations	5
3.4.1	Topographic Classes	6
4.	THE SOILS	7
4.1	Soil Formation	7
4.2	Soils of the Battle River Study Area	7
4.2.1	Alluvium (AVM) Soils	11
4.2.2	Big Knife (BKF) Soils	12
4.2.3	Cordel (COR) Soils	13
4.2.4	Elnora (EOR) Soils	14
4.2.5	Flagstaff (FST) Soils	15
4.2.6	Forestburg (FRB) Soils	15
4.2.7	Foreman (FMN) Soils	16
4.2.8	Halkirk (HKR) Soils	17
4.2.9	Heisler (HER) Soils	18
4.2.10	Irma (IRM) Soils	19
4.2.11	Killam (KLM) Soils	20
4.2.12	Metisko (MET) Soils	21
4.2.13	Red Willow (RED) Soils	21
4.2.14	Paintearth (PTE) Soils	22
4.2.15	Sullivan Lake (SUL) Soils	23
4.2.16	Torlea (TOL) Soils	24
4.2.17	Wainwright (WWT) Soils	25
4.2.18	Riverbank Complex (RB)	25
5.	SOIL CAPABILITY FOR AGRICULTURE	26

continued . . .

TABLE OF CONTENTS (CONCLUDED)

		Page
6.	REFERENCES	33
7.	APPENDICES	34
7.1	Definition of Soil Horizon Symbols Pertinent to the Battle River Area	34
7.2	Chemical and Physical Analyses, Morphological and Analytical Data for Representative Soil Profiles	39
7.2.1	Detailed Descriptions and Analyses of the Soils ...	39
7.3	Definition of Terms	55
7.3.1	Soil Texture	55
7.3.2	Soil Structure and Consistence	56
7.3.3	Soil Moisture Classes	57
7.3.4	Calcareous Classes	58
7.3.5	Reaction Classes	58
7.3.6	Stoniness	59
7.3.7	Horizon Boundaries	59
7.3.8	Roots	60
7.4	Glossary of Terms	60

LIST OF TABLES

Page

1. A Summary of the Soils that Occur in the Battle River Area 10

2. Soil Capability Ratings for the Battle River Area 29

LIST OF FIGURES

		Page
1.	Location of the Study Area	2
2.	Diagram of the Soil Profile Showing Various Horizons	8
3.	Sketch Showing the Relationships Between Alluvium and Associated Soil Units	11
4.	Sketch Showing the Relationships Between Big Knife and Associated Soil Units	12
5.	Sketch Showing the Relationships Between Cordel and Associated Soil Units	13
6.	Sketch Showing the Distribution of Soils Within the Elnora 3 Soil Unit	14
7.	Sketch Showing the Distribution of Soils Within the Foreman 1 Soil Unit	16
8.	Sketch Showing the Distribution of Soils Within the Halkirk 1 Soil Unit	17
9.	Sketch of the Soil Parent Material and Underlying Strata of the Irma 1 Soil Unit	19
10.	Sketch Showing the Distribution of Soils Within the Killam 4 Soil Unit	20
11.	Sketch Showing the Distribution of Soils Within the Paintearth 2 Soil Unit and the Relationship with Associated Soil Units	22
12.	Sketch Showing the Distribution of Soils Within the Sullivan Lake 1 Soil Unit	23
13.	Sketch Showing the Distribution of Parent Materials Associated with the Torlea 1 Soil Unit	24
14.	Sketch Showing the Distribution of Soils Within the Riverbank 1 Soil Unit and the Relationship with Associated Soil Units	25

ADRIAN HENRY MACLEAN

(1938-1980)

Adrian MacLean died suddenly as a result of injuries sustained in an automobile accident July 25, 1980. He was 42.

Adrian was born in London, England. He obtained a B.Sc. in Agriculture in 1962 at London University (Wye College). His M.Sc. was obtained in 1964 from the University of Guelph where he studied phosphorous in relation to soil genesis. Adrian received his Ph.D. in Soil Science from the University of Alberta in 1974. His research involved a study of the relationships between groundwater (salinity and direction of flow) and soil types in the Vegreville area.

From 1965 to 1967 Adrian worked as part of a soil survey team mapping the Ludlow area of England. From 1967 to 1979 he was employed at the Kaufe Irrigation Research Station in Zambia. There he conducted research trials on various aspects of irrigation. Adrian joined the University of Alberta in 1974 and worked on a study of oil breakdown in soils and then as the soil physicist in the Alberta Oil Sands Environmental Research Program. This work involved investigation of water balance at natural forest sites and on reclaimed mine-tailings sand. Adrian was employed by the Soils Department at the Alberta Research Council in August 1979 to work in the soils component of the Plains Hydrology and Reclamation Project (PHRP), being conducted in the Battle River area near Forestburg.

Adrian was an avid outdoorsman and was heavily involved in youth work.

We are proud to have been associated with Adrian and feel his loss as a colleague on the PHRP and as a friend.

PREFACE

This is one of a series of reports that presents the findings of the PHRP, an interdisciplinary study that focuses primarily on hydrologic aspects of reclamation of surface coal mines in the plains of Alberta. This research has been conducted by the Research Council, as part of the Alberta Government's Reclamation Research Program. The program is managed by the Land Conservation and Reclamation Council and is supported by the Heritage Trust Fund.

The focus of the PHRP is to develop a predictive framework that will permit projection of success for reclamation and impact of mining on water resources on a long-term basis. The predictive framework is based on an understanding of processes acting within the landscape so that in the future, mine sites that are not totally analogous to those that have been studied can be evaluated as well.

The project involves a holistic approach to reclamation by integration of studies of geology, hydrogeology, and soils, not only in the proposed mining area, but also in the adjoining unmined areas. This approach permits the assessment of impacts and of long-term performance, not only in reclaimed areas, but also in the surrounding area.

The research of the PHRP was directed toward the following two major objectives and eight subobjectives.

Objective A

To evaluate the potential for reclamation of lands to be surface mined. The focus is on features of the landscape that make it productive in a broad sense not restricted to revegetation. This objective was organized into five subobjectives.

1. To assess and evaluate the potential for long-term degradation of reclaimed soils through salt buildup.
2. To assess and evaluate the effectiveness of topographic modification and selective placement of

materials to mitigate deleterious impacts on chemical quality of groundwater.

3. To assess the availability of water supply in or beneath cast overburden to support post-mining land use, including both quantity and quality considerations.
4. To evaluate the productivity potential (capability) of post-mining landscapes and the significance of changes in capability as a result of mining.
5. To assess and evaluate limitations to post-mining land use posed by physical instability of cast overburden.

Objective B

To evaluate the long-term impact of mining and reclamation on water quantity and quality. This objective was organized into three subobjectives.

1. To assess and evaluate the long-term alteration of quality of groundwater in cast overburden and surface water fed from mine spoil as a result of the generation of weathering products.
2. To assess and evaluate infiltration, groundwater recharge, and groundwater-surface water interactions within cast overburden.
3. To characterize the groundwater chemistry generated within cast overburden.

Studies directed at these objectives began in 1979 at the Battle River site in east-central Alberta. Work began in 1982 at a second study area at Highvale Mine south of Lake Wabamun. Significant progress had been made on all project objectives by the end of the first phase of study in March 1984. This present series of reports summarizes the state of our knowledge at the end of this first phase of study. Work is now continuing on the Phase II objectives to gain an even greater understanding of the complex, physical and chemical processes in reclaimed landscapes.

This report addresses Subobjective A-4: To evaluate the productivity potential (capability) of post-mining landscapes and the significance of changes in capability as a result of mining. This report provides detailed soils information for the Battle River site. The report was prepared from data collected from 1979 through 1985. Four soil maps at a scale of 1:10 000 supplement this report to illustrate the topographic features and the location and extent of the individual soil areas in the unmined and mined settings. The field information and analytical data provided a basis for assessing the capability of the unmined and reconstructed soils for agricultural production. The soil capability for agriculture ratings are presented on four maps at a scale of 1:10 000 which also supplement this report.

ABSTRACT

The detailed-soil survey of the Battle River area comprises a portion of the soils-related research activities associated with the Plains Hydrology and Reclamation Project. The project is being conducted by the Alberta Research Council in the Battle River area near Forestburg, Alberta.

The survey was conducted to provide detailed-soils information for lands adjacent to areas already mined and lands destined to be mined, as well as to characterize the "reconstructed" soils in the reclaimed areas. This information will provide a basis for assessing the capability of the soils for agricultural production prior to mining and will, also, be useful for future reference when considering the effects of surface mining on adjacent unmined areas.

The survey aided in the selection of locations for establishment of research sites. Information derived during the mapping process allowed for an assessment of the type and extent of soils in the region, thereby providing for selection of representative soils and specific sites thereof. These sites were instrumented to characterize moisture regimes and soil water movement in the unmined situation to provide for a comparison to similar characterization and monitoring at reclaimed-land sites.

Four soil maps supplement this report. These maps, published at a scale of 1:10 000, show the topographic features and the location and extent of the individual soil areas.

The report outlines the system and methods that were employed in soil mapping. Soils are described on the basis of soil groups.

The soil capability for agriculture system was used to group the soils for agricultural interpretations and the appropriate ratings are presented on four maps which also supplement this report.

Four appendices follow the report. The first defines the soil horizon symbols pertinent to the Battle River area; the second gives detailed descriptions of the soils and pertinent analytical data; the third provides definitions of some of the descriptive terms

used in the report relative to characterizing and mapping; and the fourth appendix is a glossary of common used-soil terms.

ACKNOWLEDGEMENTS

The detailed-soil survey of the Battle River project area comprised a portion of the PHRP being conducted by the Research Council.

Funds for the field work and for compilation of the report and maps were supplied by the Alberta Heritage Savings Trust Fund through a research contract administered by the Reclamation Research Technical Advisory Committee of the Land Conservation and Reclamation Council. The University of Alberta provided some of the laboratory accommodations needed for analytical work.

The final soils and soil capability for agriculture rating maps were drafted by J. Dlask, Graphic Services, Research Council.

Technical laboratory assistance for this study was provided by A. Schwarzer, J. Beres, W.C. McKean, and P. Yeung. R. Labbe, C. Lizzi, R. Sherstabetoff, and M. Tenove assisted in the field mapping. Z. Widtman assisted in the field and also in the compilation of the report and maps.

Appreciation is expressed to the many landowners, including Manalta Coal Ltd. and Luscar Ltd., for allowing access to their properties.

1. LOCATION AND EXTENT OF THE STUDY AREA

The soil survey of the PHRP - Battle River project area comprises an area of approximately 10 700 ha in townships 39, 40, and 41, ranges 15 and 16, west of the 4th meridian. The area mapped is shown in Figure 1 and includes lands adjacent to the existing operations and proposed mine areas of Luscar Ltd. and Manalta Coal Ltd. The survey also includes reconstructed soil areas within the Diplomat and Vesta Mine sites.

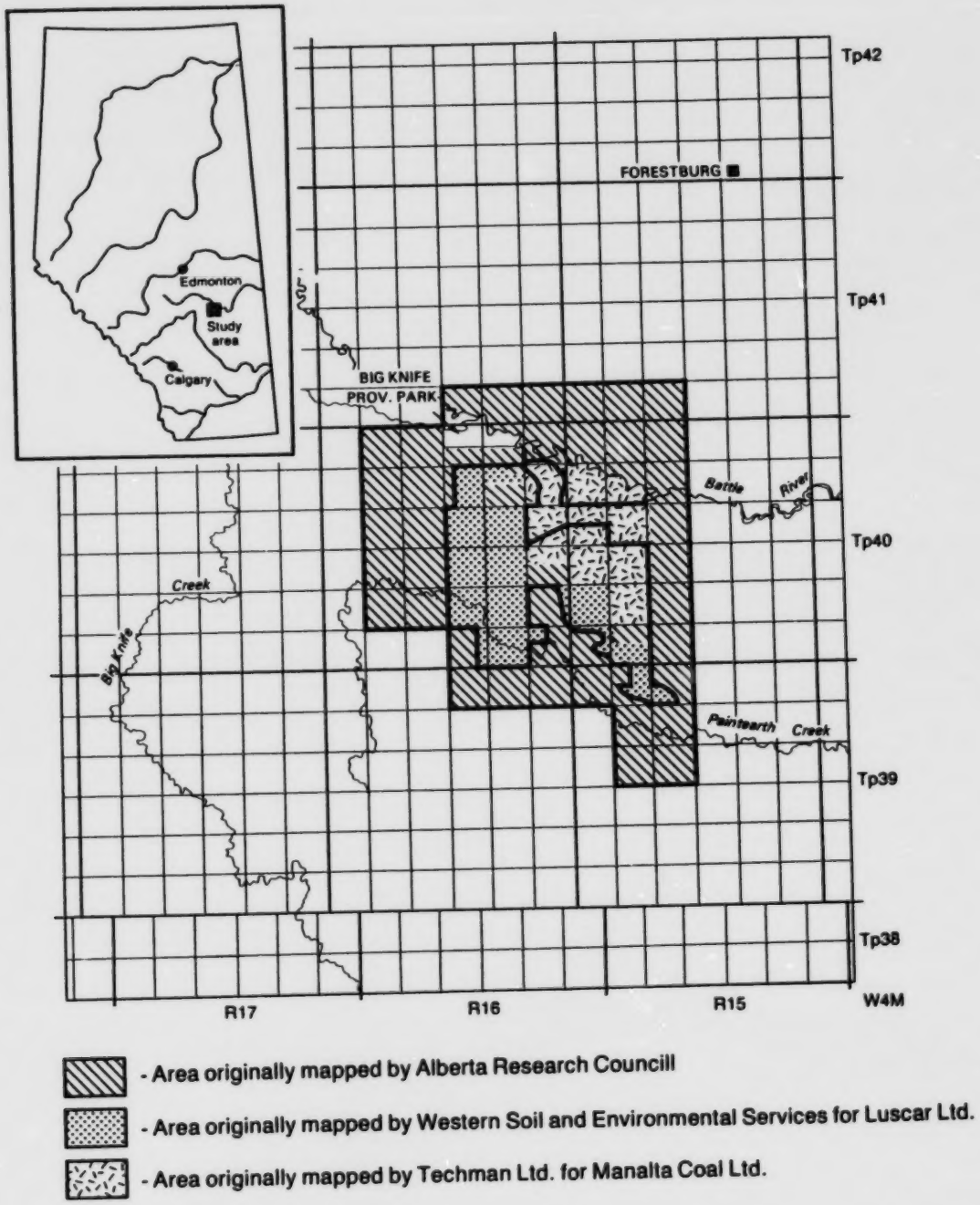

Figure 1. Location of the study area.

2. SOIL MAPPING PROCEDURES

The soils of the study area were mapped by examining the soils at 2200 sites. This allowed for an average inspection density of approximately 16 observations per quarter section, or one observation per 4 ha (10 a).

The mapping in the unmined areas was done on the conventional basis of making point observations and extrapolating to some extent by air-photo interpretation. However, a minimal amount of extrapolation was required in light of the observation density employed in the survey.

The soils were classified in accordance with the Canadian System of Soil Classification (Canada Soil Survey Committee 1978). The soil map was presented on an uncontrolled photo mosaic in four parts at a scale of 1:10 000.

Conventional methods could not be used for mapping the mined (reclaimed) lands. The use of map units in the usual sense was not possible because of the heterogeneity of the materials, and as a result map units were developed on the basis of materials handling history, topography, and drainage.

The initial mapping was undertaken in 1979 and 1980 and a photo mosaic format, based on photos obtained in July 1981, was used to present the soils information. The report and maps were completed in December 1982.

In 1985 work was undertaken to combine the information provided by the above mentioned report with the information provided in the reports entitled "Detailed Soil Survey and Interpretations for Reclamation of the Paintearth Mine Area" (Forestburg Collieries Ltd. 1979) and "Soil and Till Inventory and Reclamation Suitability Assessment, Vesta Mine, Halkirk, Alberta" (Manalta Coal Ltd. 1979). The map information relative to the three separate projects was compiled on one photo mosaic prepared from aerial photographs flown August 18, 1985. The maps accompanying this report, therefore, provide an indication of the extent of mining, as of this date.

In order to prepare this map compilation, the soil legends and symbols for the Paintearth and Vesta Mine maps were modified to coincide with those utilized by Macyk and MacLean. The boundaries were checked and areas, within the study area that had not previously been mapped, were completed.

3. EXPLANATORY NOTE ON THE SOIL MAP AND LEGEND

This section explains the various categories and terms employed in the legend that accompanies the soil map.

3.1 SOIL GROUP

A soil group is a group of closely interrelated soils series developed on similar parent materials in relatively similar climates. The broad soil groups are subdivided into soil units that are found in predictable geographic association, yet have different profile morphologies and drainage regimes. Soil groups are a mapping convenience used to bring together various collections of soils in order to focus on certain pertinent aspects of the landscape.

3.2 SOIL UNIT

Soil units are areal subdivisions of soil groups such that within a given soil unit the component soil types are found in certain proportions. The symbols on the map representing these units identify both the group and the proportions of the soils within the unit and, also, indicate the relative landscape and associated drainage conditions.

3.3 DOMINANT SOILS AND SIGNIFICANT SOILS

These terms refer to the relative proportion of various soils as they are found in a natural soil unit. Within a soil unit, dominant soils occupy over 40% of the area, while significant soils occupy over 15%, but less than 40% of the area. In most cases, only a single soil is indicated as dominant or as significant.

3.4 SOIL MAP NOTATIONS

Each individual soil area is shown on the soil map enclosed in a boundary line. The soil area within each delineation is identified by a collection of symbols arranged in the following manner:

Soil Group Soil Unit	HKR1
Topographic Class(es)	c

3.4.1 Topographic Classes

The following are the topographic classes and symbols used in this report and on the accompanying maps:

Class	Description	Slope (%)
a	nearly level	0.0 to 0.5
b	gently undulating	0.5+ to 2.0
c	undulating	2.0+ to 5.0
d	gently rolling	5.0+ to 9.0
e	moderately rolling	9.0+ to 15.0
f	strongly rolling	15.0+ to 30.0
g	hilly	30.0+ to 60.0
h	very hilly	over 60

4. THE SOILS

4.1 SOIL FORMATION

Soil is a dynamic, organized, natural body on the surface of the earth that contains living matter and that supports or is capable of supporting plants. It includes all layers or horizons differing from the underlying parent material as a result of a complex and continuous process involving interaction among climate, biological activity, parent material, relief and drainage, and time. These layers or horizons differ from each other in aspects of colour, structure, texture, consistence, reaction, and thickness, as well as in chemical and biological composition. Master soil horizons are designated L, F, H, or O for organic horizons and A, B, or C for mineral horizons. Lower case letter suffixes are used to indicate the type of horizons and Arabic numeral suffixes are used when further division into subhorizons is required. Roman numeral prefixes are used to show the presence of lithologically nonconforming parent materials in one profile. Master horizon designations and lower case suffixes are defined in Appendix 7.1. A diagrammatic example of the use of these is given in Figure 2.

4.2 SOILS OF THE BATTLE RIVER STUDY AREA

Eighteen soil groups developed on a wide range of different parent materials were recognized and characterized in the unmined areas. Soil descriptions including classification, location, parent material, landform, topography, drainage, and soil profile characteristics are presented in this section of the report. Descriptions and pertinent analytical data of profiles considered to be representative of the various soil groups are found in the appendices.

According to the soil group map of Alberta, the study area lies in the transition between the black and dark brown soil zones. Surface horizon colour provided the basis for separating the soils in the field, however, it should be noted that the differences that do occur in the transition zone are rather subtle.

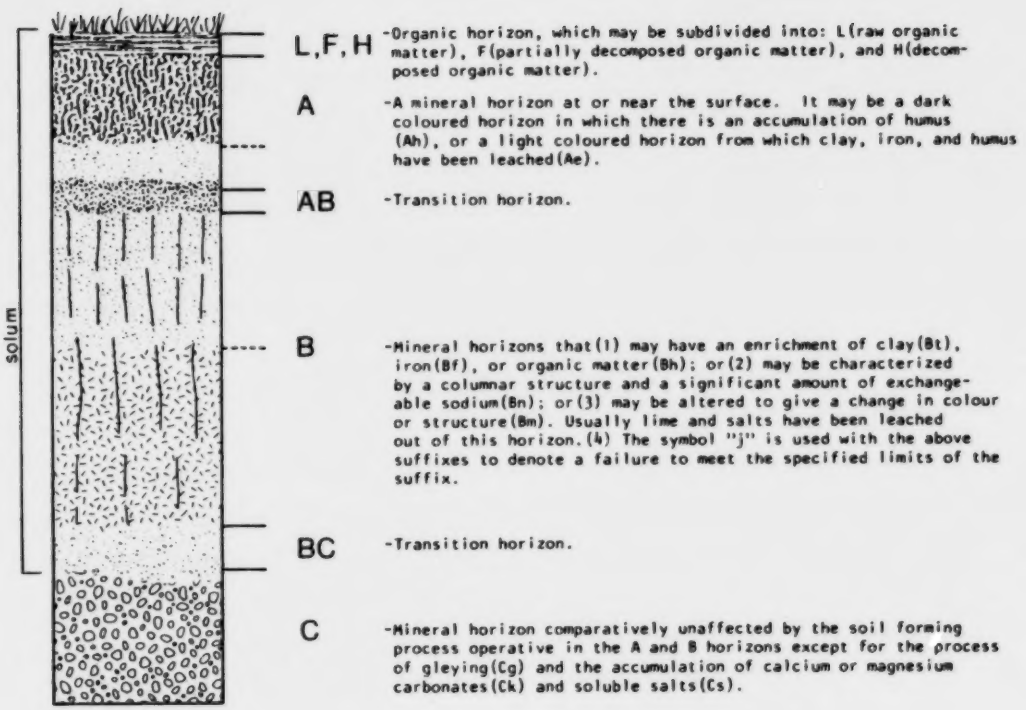
solum
L,F,H
-Organic horizon, which may be subdivided into: L(raw organic matter), F(partially decomposed organic matter), and H(decomposed organic matter).
A
-A mineral horizon at or near the surface. It may be a dark coloured horizon in which there is an accumulation of humus (Ah), or a light coloured horizon from which clay, iron, and humus have been leached(Ae).
AB
-Transition horizon.
B
-Mineral horizons that(1) may have an enrichment of clay(Bt), iron(Bf), or organic matter(Bh); or(2) may be characterized by a columnar structure and a significant amount of exchangeable sodium(Bn); or(3) may be altered to give a change in colour or structure(Bm). Usually lime and salts have been leached out of this horizon.(4) The symbol "j" is used with the above suffixes to denote a failure to meet the specified limits of the suffix.
BC
-Transition horizon.
C
-Mineral horizon comparatively unaffected by the soil forming process operative in the A and B horizons except for the process of gleying(Cg) and the accumulation of calcium or magnesium carbonates(Ck) and soluble salts(Cs).

Figure 2. Diagram of the soil profile showing various horizons.

A summary of the soil groups that were mapped in the study area is presented in Table 1.

Eight categories were established for separation of units in the reconstructed soil areas. Pertinent analytical data for these units are provided in the Summary Report of Activities, 1982-1983, for the PHRP. Brief descriptions of the units follow:

RC1 - denotes areas where the spoil piles are essentially untouched and basically retain their original configuration

RC2 - denotes areas where the spoil piles are leveled to some extent. The extent of leveling is variable

RC3 - denotes areas where the spoil piles are leveled and subsequently topsoiled

RC4 - denotes areas where the spoil piles are leveled, subsoiled, and topsoiled

RC5 - denotes areas where the spoil piles are leveled and covered with ash

RC6 - denotes areas where the leveling of spoil piles is complete or in progress at the time of mapping. RC6 areas differ from RC2 areas in that the RC6 areas will have soil materials replaced on the leveled spoil. At RC2 areas no additional reconstruction work is anticipated following the leveling of the spoil

RC7 - denotes areas where seasonal ponding occurs. The delineations are based on conditions that existed when the aerial photographs were obtained and are subject to change

RC8 - denotes areas where the land surface is disturbed or manipulated to some extent, but actual mining in the sense of developing pits and spoil piles has not occurred. These areas generally occur adjacent to mined areas.

Table 1. A summary of the soils that occur in the Battle River area.

Till Parent Material	
Soil Group	Dominant Soil
Cordel	Humic Luvic Gleysol
Elnora	Orthic Black
Flagstaff	Solonetzic Dark Brown
Foreman	Gleyed Black Solonetz
Halkirk	Dark Brown Solodized Solonetz
Heisler	Solonetzic Black
Killam	Black Solodized Solonetz
Fluvial Parent Material	
Soil Group	Dominant Soil
Irma	Orthic Black
Metisko	Orthic Dark Brown
Red Willow	Orthic Black
Sullivan Lake	Dark Brown Solodized Solonetz
Wainwright	Orthic Dark Brown
Residual Parent Material	
Soil Group	Dominant Soil
Forestburg	Orthic Humic Gleysol
Paintearth	Rego Dark Brown
Torlea	Dark Brown Solodized Solonetz
Alluvium Parent Material	
Soil Group	Dominant Soil
Alluvium	Orthic Dark Brown
Colluvium Parent Material	
Soil Group	Dominant Soil
Big Knife	Dark Brown Solodized Solonetz

4.2.1 Alluvium (AVM) Soils

Alluvium soil units are predominantly composed of moderately well drained Orthic Dark Brown Chernozems developed on weakly calcareous, moderately fine textured, stone-free Alluvium. These soils are found on nearly level to gently undulating topography adjacent to the Battle River and Paintearth Creek (Figure 3).

Alluvium soils have a relatively thick Ah horizon overlying a fine sandy loam to silt loam Bm horizon. The Ck horizon generally occurs at depths greater than 1 m.

Two units were used to delineate areas of Alluvium soils. The AVM 1 unit describes areas that are predominantly Orthic Dark Brown Chernozems with significant amounts (20 to 30%) of Rego Dark Brown Chernozems occurring within the unit. The AVM 2 unit describes areas that are predominantly composed of Eluviated Dark Brown Chernozems with significant amounts of Orthic Dark Brown Chernozems.

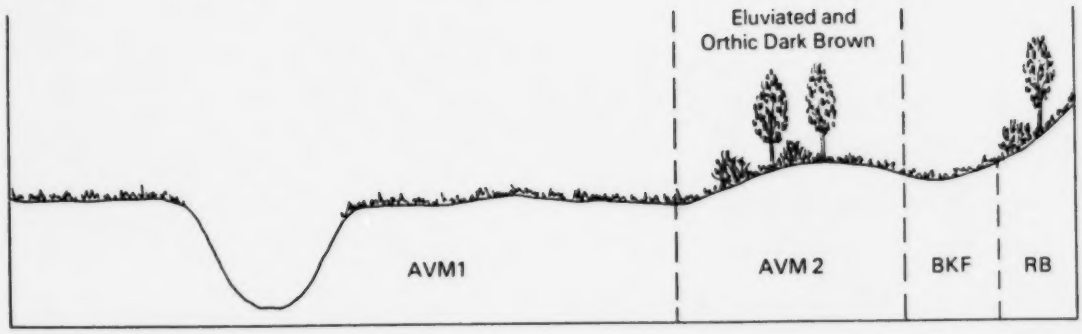

Figure 3. Sketch showing the relationships between Alluvium and associated soil units.

4.2.2 Big Knife (BKF) Soils

Big Knife soil units are predominantly composed of moderately well to imperfectly drained Dark Brown Solodized Solonetz soils developed on strongly calcareous, moderately fine textured, slightly stony Colluvium. These soils are found on gently undulating topography in the valleys of the Battle River and Paintearth Creek (Figure 4).

Big Knife soils have a thin, silty clay loam Ah horizon. The Ah is underlain by a very thin silt loam Ae horizon and relatively thin, silty clay Bnt horizon. The Csaca horizon is encountered at a depth of 25 to 35 cm below the soil surface.

The Big Knife unit may contain significant amounts (20 to 30% of Solonetzic Dark Brown soils.

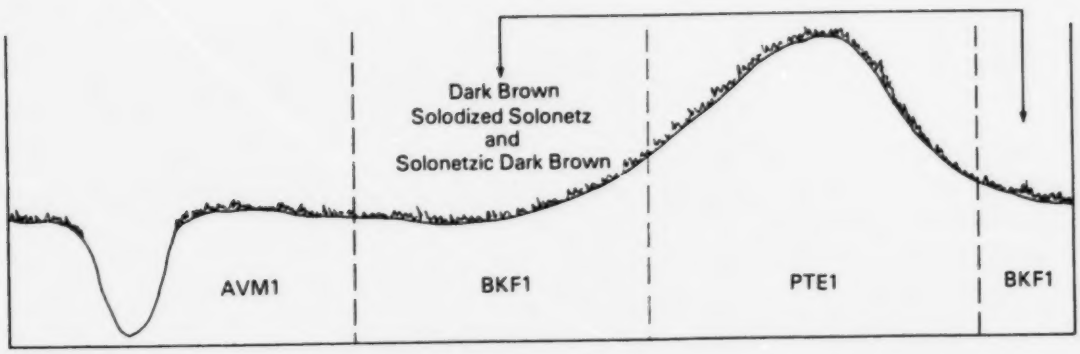

Figure 4. Sketch showing the relationships between Big Knife and associated soil units.

4.2.3 Cordel (COR) Soils

Cordel soil units are predominantly poorly drained Humic Luvic Gleysols developed on weakly calcareous, moderately fine textured, slightly stony till. These soils are found in level to depressional areas throughout the study area (Figure 5).

Cordel soils have a thin, well decomposed grass layer overlying a loam to silt loam Ah horizon and a very fine sandy loam Ae horizon. Underlying the Ae is the clay loam to clay Btg horizon. The clay loam Ccag horizon occurs at a depth of about 1 m. Mottling is indicative of seasonally high water tables.

The Cordel soil unit may include significant amounts of Orthic Humic Gleysols. Orthic Humic Gleysols differ from Humic Luvic Gleysols, in that, the former lack an eluvial Aeg horizon.

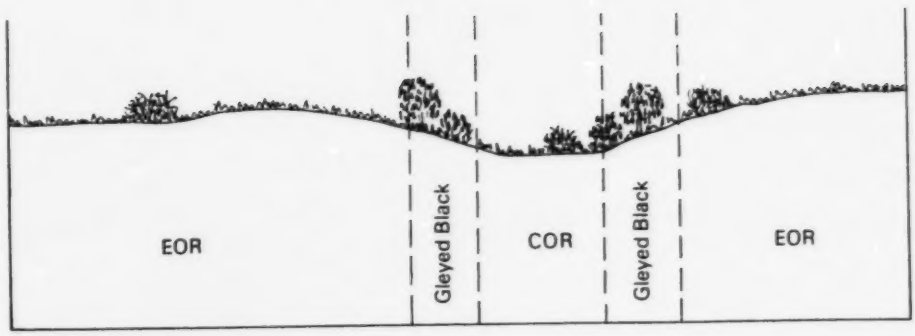

Figure 5. Sketch showing the relationships between Cordel and associated soil units.

4.2.4 Elnora (EOR) Soils

Elnora soil unit is predominantly composed of moderately well drained Orthic Black Chernozems developed on weakly calcareous, moderately fine textured, slightly stony till. These soils are found on nearly level to gently undulating topography in the northern portion of the study area (Figure 6).

Elnora soils have a relatively thick loam to silt loam Ap horizon overlying a silty clay loam AB horizon. Underlying the AB horizon is the silty clay Bt horizon. The clay loam Cca horizon occurs at a depth of 50 cm or greater.

Five soil units were used to delineate areas of Elnora soils. The EOR 1 unit describes areas that are dominantly Orthic Black Chernozem, but that also contains significant amounts (10 to 30%) of Eluviated Black soils. The EOR 2 unit describes areas that are dominantly Orthic Black, but that also contains significant amounts (10 to 30%) of Gleyed Black soils. The EOR 3 unit is predominantly composed of Orthic Black soils and contains significant amounts (10 to 30%) of poorly drained Orthic Humic Gleysols. The EOR 5 unit is predominantly composed of Orthic Black soils, but also contains significant amounts (10 to 30%) of Solonetzic Black and Black Solonetz soils. EOR 10 units are predominantly composed of Orthic Black soils, but also contain significant amounts (40 to 50%) of Orthic Regosols. The EOR 10 unit was used to delineate areas where a significant amount of erosion, primarily water erosion, had occurred.

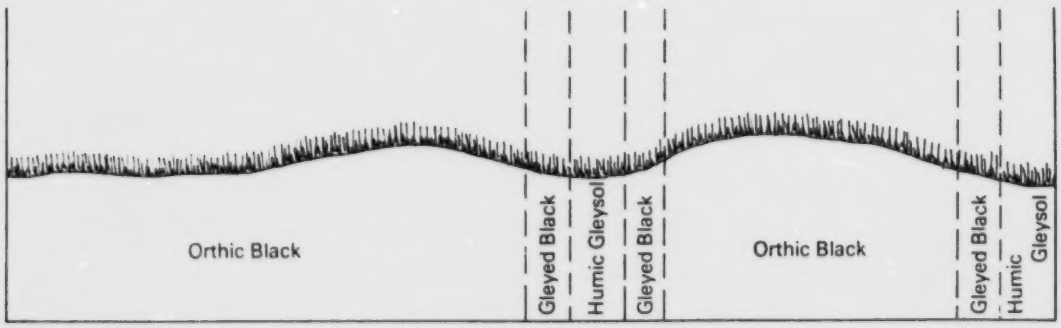

Figure 6. Sketch showing the distribution of soils within the Elnora 3 soil unit.

4.2.5 Flagstaff (FST) Soils

Flagstaff soil units are predominantly composed of moderately well drained Solonetzic Dark Brown Chernozems developed on weakly calcareous, moderately fine textured, slightly stony till. These soils are found on nearly level topography in the southeast and southwest portions of the study area.

Flagstaff soils have a relatively thick loam to silt loam Ap horizon overlying a silt loam Ae horizon. The Ae is underlain by a sandy clay loam to clay loam Bnjt horizon. The clay loam to silty clay loam Ck horizon occurs at approximately 75 cm.

Flagstaff soil units contain significant amounts (25 to 35%) of Eluviated Dark Brown Chernozems as well as Dark Brown Solodized Solonetz soils. Eluviated Dark Brown Chernozem soils lack a Solonetzic B horizon, which is diagnostic of Solonetzic soils. Dark Brown Solodized Solonetz soils differ from Solonetzic Dark Brown Chernozems in that the former have an Ae horizon and more strongly developed structure in the B horizon.

4.2.6 Forestburg (FRB) Soils

Forestburg soil units are predominantly composed of poorly drained, Orthic Humic Gleysols developed on fine textured weathered shale materials.

Forestburg soils have a relatively thin silty clay loam Ah horizon overlying a clay loam Bg horizon. The parent material consists mainly of fine textured weathered shale overlying weathered sandstone.

Forestburg soil units contain significant amounts of saline Rego Humic Gleysols.

4.2.7 Foreman (FMN) Soils

Foreman soil units are predominantly composed of imperfectly drained, Gleyed Black Solonetz soils developed on weakly calcareous, fine textured, slightly stony till. These soils are found on nearly level topography in the northwest corner of the study area (Figure 7).

Foreman soils have a thin fine sandy loam Ah or Ap horizon overlying a clay loam sodium enriched Bn horizon. The Csk horizon occurs at approximately 15 to 20 cm. Mottling is indicative of a seasonally high water table.

Foreman soil units also contain significant amounts (20 to 30%) of Black Solonetz and Saline Carbonated Gleysols. Black Solonetz soils differ from Gleyed Black Solonetz soils, in that, they lack mottles within the top 50 cm of the soil profile. Saline Carbonated Gleysols are poorly drained and salt enriched.

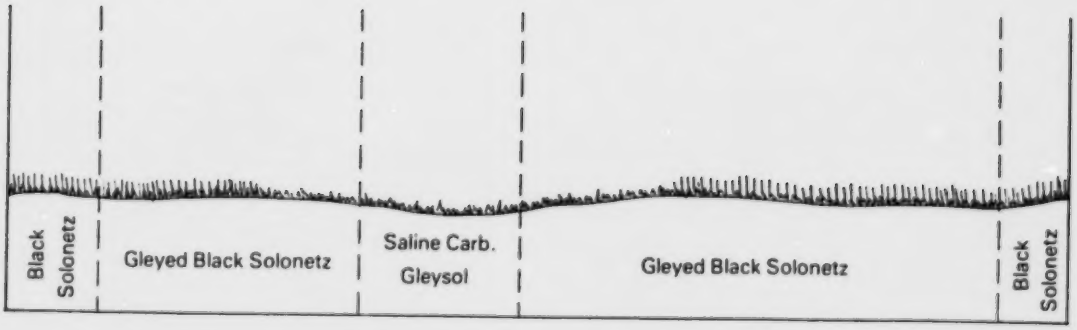

Figure 7. Sketch showing the distribution of soils within the Foreman 1 soil unit.

4.2.8 Halkirk (HKR) Soils

Halkirk soil units are predominantly composed of moderately well drained Dark Brown Solodized Solonetz soils developed on weakly calcareous, moderately fine textured, slightly stony till. These soils are found on level to gently undulating topography throughout the study area on the south side of the Battle River.

Halkirk soils have a relatively thick sandy loam to loam Ap horizon overlying a silt loam Ae horizon and silty clay Bnt horizon. The silty clay Csak horizon occurs at about 50 cm.

Three Halkirk soil units were recognized. The HKR 1 unit dominantly consists of Dark Brown Solodized Solonetz soils with significant amounts (10 to 30%) of Orthic Dark Brown and Solonetzic Dark Brown Chernozems (Figure 8). The HKR 2 unit dominantly consists of Gleyed Dark Brown Solodized Solonetz soils with significant amounts (10 to 30%) of Orthic Humic and Humic Luvic Gleysols. The HKR 3 unit dominantly consists of Dark Brown Solodized Solonetz soil with significant amounts (10 to 30%) of Dark Brown Solodized Solonetz soils developed on residual material (soils of Torlea unit).

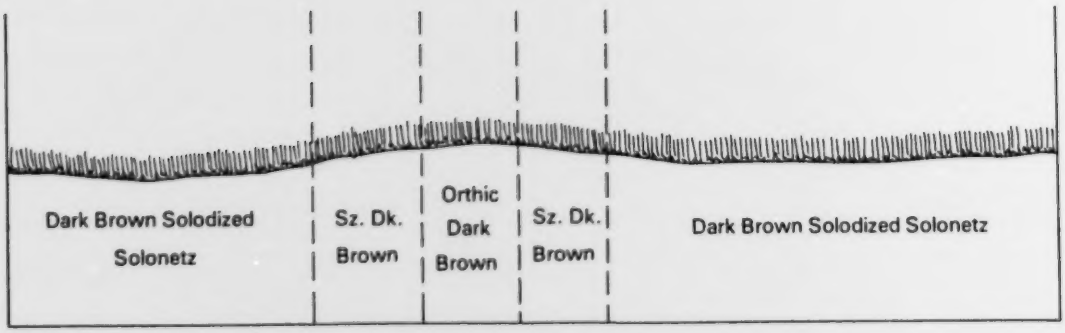

Figure 8. Sketch showing the distribution of soils within the Halkirk 1 soil unit.

4.2.9 Heisler (HER) Soils

Heisler soil units are predominantly composed of moderately well drained Solonetzic Black Chernozem soils developed on moderately calcareous, moderately fine textured, slightly stony till. These soils are found on nearly level to gently undulating topography in the northeast corner of the study area.

Heisler soils have a relatively thick Ah horizon overlying a fine sandy loam Ae horizon. The Ae is underlain by a sandy clay loam Bnjtj horizon. The sandy loam to sandy clay loam Csaca horizon occurs at a depth of about 75 to 80 cm.

The Heisler unit contains a significant amount (20 to 30%) of Black Solodized Solonetz soils. Black Solodized Solonetz soils differ from Solonetzic Black Chernozems, in that, they have a Solonetzic B horizon.

4.2.10 Irma (IRM) Soils

Irma soil units are predominantly composed of well drained Orthic Black Chernozems developed on weakly calcareous, coarse textured, glaciofluvial material. The glaciofluvial material overlies till at depths less than 2 m. These soils occur on level to gently undulating topography in the northwest portion of the study area.

Irma soils have a thick sandy loam Ah horizon overlying a sandy loam to loamy sand Bm horizon. The IICca horizon generally occurs at about 100 to 120 cm.

Three soil units were used to delineate areas of Irma soils. The IRM 1 unit contains mainly Orthic Black Chernozems (Figure 9). The IRM 2 unit is dominantly Orthic Black Chernozemic, but also contains significant amounts (20 to 30%) of Gleyed Black, Chernozems. The IRM 3 unit differs from the IRM 2 unit, in that, it has a very thin (20 to 100 cm) glaciofluvial veneer overlying till.

The Gleyed Black Chernozems differ from Orthic Black Chernozems, in that, they have mottling within the top 50 cm of the soil profile. Mottling is indicative of seasonally high water tables.

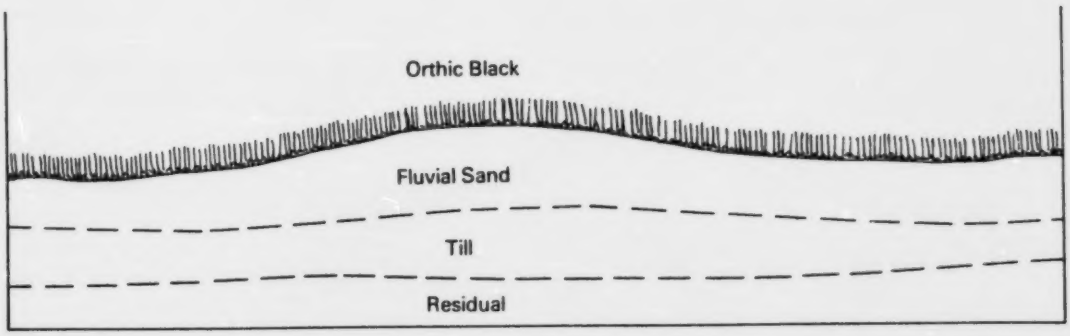

Figure 9. Sketch of the soil parent material and underlying strata of the Irma 1 soil unit.

4.2.11 Killam (KLM) Soils

Killam soil units primarily consist of moderately well drained Black Solodized Solonetz soils developed on moderately calcareous, moderately fine textured, slightly stony till. These soils are found on level to gently undulating topography in the northern portion of the study area.

Killam soils have a relatively thick loam Ap horizon that overlies a thin fine sandy loam Ae horizon. The Ae is underlain by a clay loam Bnt horizon. The clay loam Csaca horizon usually occurs at a depth of about 60 to 65 cm.

Four units were used to delineate areas of Killam soils. The KLM 1 unit represents areas that contain predominantly Black Solodized Solonetz soils. The KLM 2 unit represents areas that are dominantly Black Solodized Solonetz, but that also contains significant amounts (10 to 20%) of Gleyed Black Solodized Solonetz soils. The KLM 3 unit is dominated by Black Solodized Solonetz soils, has significant amounts (20%) of Gleyed Black Solodized Solonetz, and also contains inclusions (10%) of Orthic Humic Gleysols. The KLM 4 soil unit is dominantly Black Solodized Solonetz, has significant amounts (20%) of Solonetzic Black Chernozems, and also contains inclusions (10%) of Black Solonetz soils (Figure 10).

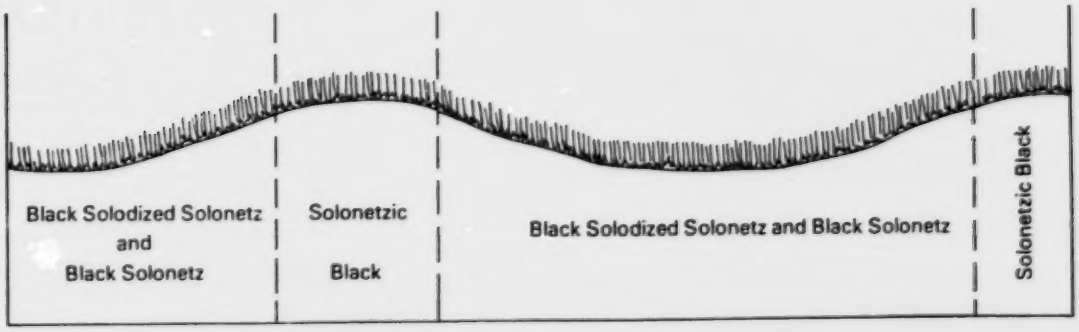
Black Solodized Solonetz and Black Solonetz
Solonetzic Black
Black Solodized Solonetz and Black Solonetz
Solonetzic Black

Figure 10. Sketch showing the distribution of soils within the Killam 4 soil unit.

4.2.12 Metisko (MET) Soils

Metisko soil units are predominantly composed of well drained Orthic Dark Brown Chernozems developed on weakly calcareous, coarse textured, glaciofluvial sands overlying weathered residual material. These soils are found on gently undulating topography in the west, half of the study area.

Metisko soils have a relatively thick sandy loam Ah horizon overlying a sandy loam Bm horizon. The Ck horizon generally occurs at a depth of 100 to 120 cm.

Metisko soil units also contain significant amounts of Rego Dark Brown Chernozems. Rego Dark Brown Chernozems differ from Orthic Dark Brown Chernozems, in that, the former lack a Bm horizon.

4.2.13 Red Willow (RED) Soils

Red Willow soil units are predominantly composed of well to rapidly drained Orthic Black Chernozems developed on weakly calcareous coarse textured, glaciofluvial sands overlying till and/or residual material. These soils are found on level to gently undulating topography in the northwest portion of the study area.

Red Willow soils are quite similar to Irma soils except that Irma soils have a sandy loam surface texture and the Red Willow soils have a loamy sand surface texture.

Two soil units were used to delineate areas of Red Willow soils. The RED 1 unit involves areas that are dominantly Orthic Black Chernozemic. The RED 2 unit involves areas that are dominantly Orthic Black Chernozemic, but that also contains significant amounts (20 to 30%) of imperfectly drained Gleyed Black Chernozems.

4.2.14 Paintearth (PTE) Soils

Paintearth soil units are predominantly well drained Orthic Dark Brown Chernozems developed on noncalcareous shale. These soils are found on hilly topography along Paintearth Creek and the Battle River.

Paintearth soils have a thick sandy loam Ah horizon overlying a sandy loam Bm horizon. The C horizon generally occurs at a depth in excess of 1 m.

Two units were used to delineate areas of Paintearth soils (Figure 11). The PTE 1 unit is dominantly Rego Dark Brown Chernozemic with significant amounts (20 to 30%) of Orthic Dark Brown Chernozems. The PTE 2 unit is dominantly Orthic Dark Brown Chernozemic with significant amounts (20 to 30%) of Rego Dark Brown Chernozems.

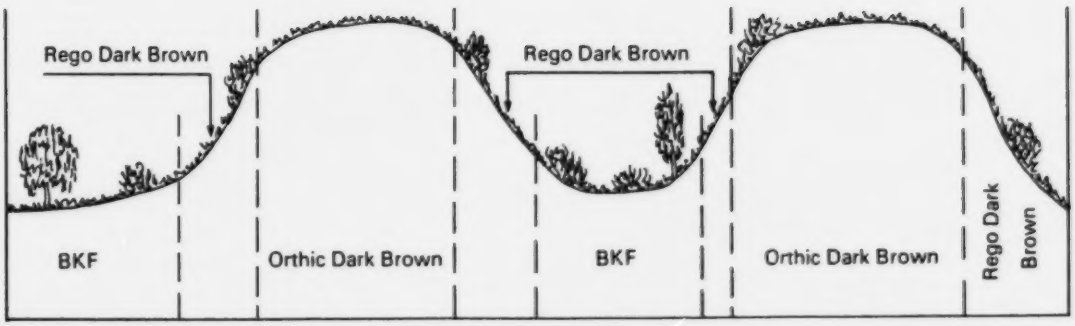

Figure 11. Sketch showing the distribution of soils within the Paintearth 2 soil unit and the relationship with associated soil units.

4.2.15 Sullivan Lake (SUL) Soils

Sullivan Lake soil units are predominantly composed of moderately well drained Dark Brown Solodized Solonetz soils developed on weakly calcareous, coarse textured, glaciofluvial deposits overlying weathered residual material. These soils are found on nearly level to gently undulating topography in the southern half of the study area (Figure 12).

Sullivan Lake soils have sandy loam Ah or Ap and Bm horizons. Underlying the Bm is a thin fine sandy loam Ae horizon and a sandy clay loam Bnt horizon. The clay loam Ck horizon occurs at a depth of about 50 to 60 cm.

Sullivan Lake soil units also contain significant amounts (20 to 30%) of Orthic Dark Brown Chernozem soils.

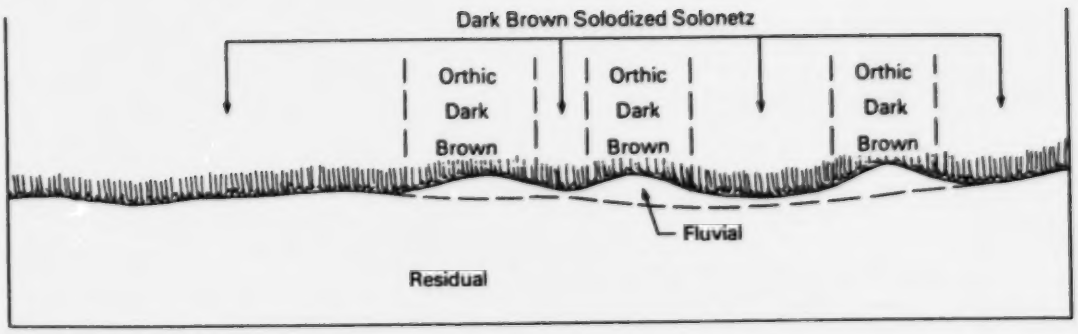

Figure 12. Sketch showing the distribution of soils within the Sullivan Lake 1 soil unit.

4.2.16 Torlea (TOL) Soils

Torlea soil units are predominantly composed of moderately well to imperfectly drained Dark Brown Solodized Solonetz soils developed on moderately calcareous, fine textured residual material. These soils are found on nearly level to gently undulating topography throughout the southern portion of the study area.

Torlea soils have a relatively thin fine sandy loam Ah horizon overlying a very thin fine sandy loam Ae horizon. The Ae horizon is underlain by a very strongly developed Bnt horizon and a Csk horizon that commonly occurs at a depth of 30 to 35 cm.

Three units were used to delineate areas of Torlea soils. The TOL 1 unit is dominantly Dark Brown Solodized Solonetz with significant amounts (10 to 30%) of Dark Brown Solodized Solonetz developed on till (Figure 13). The TOL 2 unit is dominantly Dark Brown Solodized Solonetz with significant amounts (30 to 50%) of Dark Brown Solodized Solonetz developed on till. The TOL 3 unit is dominantly Dark Brown Solodized Solonetz with significant amounts (10 to 30%) of Dark Brown Solodized Solonetz developed on till overlying sandstone.

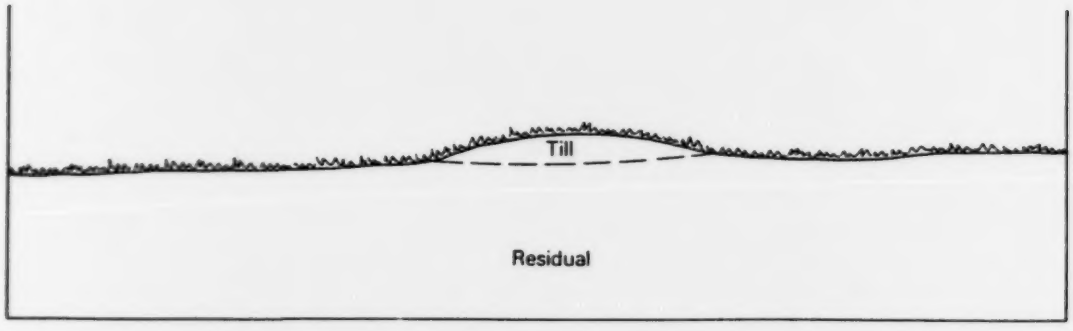

Figure 13. Sketch showing the distribution of parent materials associated with the Torlea 1 soil unit.

4.2.17 Wainwright (WWT) Soils

Wainwright soil units are predominantly composed of Orthic Dark Brown Chernozems developed on weakly calcareous glaciofluvial sands overlying residual material. These soils are found on level to gently undulating topography in the northwest corner of the study area.

Wainwright soils are quite similar to Metisko soils, except that Metisko soils have a sandy loam surface texture and the Wainwright soils have a loamy sand surface texture.

Wainwright soil units contain significant amounts of Rego Dark Brown Chernozemic soils.

4.2.18 Riverbank Complex (RB)

Soils of the Riverbank complex are predominantly moderately well to well drained Rego Chernozems developed on till, residual, and/or glaciofluvial deposits. These soils are found on moderate to steep slopes along the Battle River and Paintearth Creek (Figure 14).

Riverbank soils generally have an Ah, Ck horizon sequence. The Riverbank unit may contain significant amounts of Regosolic soils.

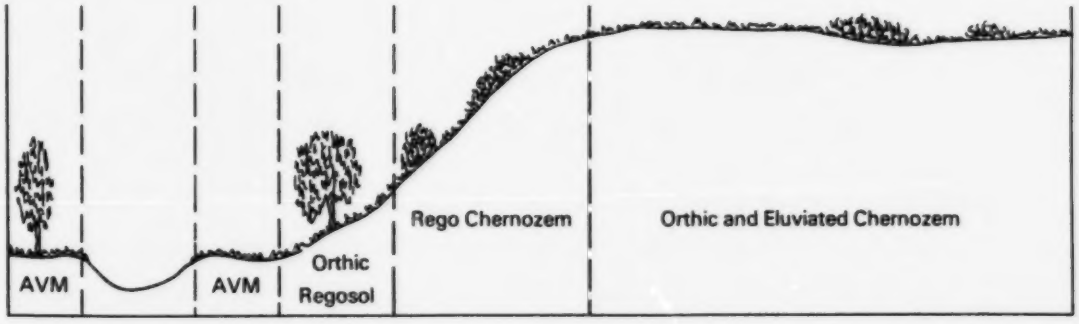

Figure 14. Sketch showing the distribution of soils within the Riverbank 1 soil unit and the relationship with associated soil units.

5. SOIL CAPABILITY FOR AGRICULTURE

The soil capability classification for agriculture is an interpretive soil grouping that can be made from soil survey data (Agricultural Rehabilitation and Development Act 1965). This classification system provides a method of evaluating the potential of a soil to produce certain crops.

The capability classification consists of two main categories: 1) the capability class - a grouping of subclasses having the same relative degree of limitation and hazard, and 2) the capability subclass - a grouping of soils with similar kinds of limitations and hazards. Mineral soils are grouped into seven classes according to their potentials and limitations for agricultural use. The classes are defined as follows:

Class 1: soils in this class have no significant limitations in use for crops

Class 2: soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices

Class 3: soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices

Class 4: soils in this class have severe limitations that restrict the range of crops or require special conservation practices

Class 5: soils in this class have very severe limitations that restrict their capability to produce perennial forage crops, and improvement practices are feasible

Class 6: soils in this class are only capable of producing perennial forage crops, and improvement practices are not feasible

Class 7: soils in this class have no capability for arable culture or permanent pasture

Organic soils are not placed in capability classes and are indicated by the letter "O".

The capability subclasses are based on characteristics that place limitations on the agricultural use of the soil. They are as follows:

Subclass C: adverse climate
Subclass D: undesirable soil structure and/or low permeability
Subclass E: erosion damage
Subclass F: low natural fertility
Subclass I: inundation (flooding by streams or lakes)
Subclass M: moisture (low moisture holding capacity)
Subclass N: salinity
Subclass P: stoniness
Subclass S: soil limitations - a combination of two or more of the Subclasses D, F, M, and N
Subclass T: adverse topography
Subclass W: excess water
Subclass X: minor cumulative limitations

Climate, soil properties, and topography are the prime considerations in assessing areas for agricultural use.

Factors not considered in developing the rating include distance to market, kind of roads, size of farms, type of ownership, cultural patterns, skill or resources of individual operators, and hazard of crop damage by storms.

Because soils having different limitations are not always separable in the field at the scale of mapping used, groupings are made for the agricultural capability classification.

The ratings are provided in tabular form (Table 2), whereby all soil map units and combinations of map units in the area are listed alphabetically and a rating applied. All combinations of topography and degree of stoniness are included. The soil capability for agriculture ratings are also presented on four maps which accompany this report.

As mentioned previously, climate is a major factor in assessing soil capability for agriculture. The study area occurs within agroclimatic Subregion 1 (Bowser 1967).

The following information is provided as an aid in interpreting the soil ratings. The large Arabic numerals denote capability classes. Letters placed after class numerals denote the subclasses or limitations. Arabic numerals placed after a class letter give the approximate proportion of the class out of a total of 10. Examples,

Rating	Description
1	denotes an area of Class 1 soils with no limitations
$1^{8}2D^{2}$	denotes an area of Class 1 soils with no limitation and Class 2 soils with undesirable structure limitations in the proportion of 8:2
$3D^{7}6\frac{W^{3}}{N}$	denotes an area of Class 3 soils with undesirable structure limitations and Class 6 soils with excess moisture and salinity in the proportion of 7:3.

Table 2. Soil capability ratings for the Battle River area.

Map Unit	Soil Rating	Map Unit	Soil Rating
AVM1/b	4M	COR1/c	6W
AVM1/b-c	4M	COR2/b	6W
AVM1/c	4M	EOR1/a	1
AVM1/c-d	5^{M}_{T}	EOR1/b	1
AVM2/c	4M	EOR1 (S)/b	4P
AVM2/d	5^{M}_{T}	EOR1/b-c	1
BKF1/b-c	5D	EOR1/c	1
BKF1/c	5D	EOR1/S/c	4P
BKF1/c-d	5D	EOR1/c-d	2T
BKF1/c-e	5D	EOR1/d	3T
BKF1/d	5D	EOR1/e	4T
BKF1/d-e	5^{T}_{D}	EOR1/f-g	6T
BKF1/d-f	6T	EOR1/g	6T
BKF1/e	5^{T}_{D}	EOR5/S/c	4P
BKF1/e-f	6T	EOR5/S/b	4P
COR1/a	6W	EOR2/c	1
COR1/b	6W	EOR2/b	1

continued . . .

Table 2. Continued.

Map Unit	Soil Rating	Map Unit	Soil Rating
EOR2 d	3T	EOR10 e	$4T^{6}4E^{4}$
EOR5/S b	3M	FMN1 a-b	$4D^{7}6W_{N}^{3}$
EOR2 d-e	4T	FMN1 b	$4D^{7}6W_{N}^{3}$
EOR2 e	4T	FST1 b	$1^{8}2D^{2}$
EOR2 g	6T	FST1 c	$1^{8}2D^{2}$
EOR3 b	$1^{9}6W^{1}$	FST1 d	3T
EOR3 c	$1^{9}6W^{1}$	FST1 d-e	4T
EOR3 e	$4T^{9}6W^{1}$	HER1 b	$1^{8}2D^{2}$
EOR3 f-g	6T	HER1 b-c	$1^{8}2D^{2}$
EOR5/S b-c	4P	HKR1 b-c	$3D^{7}1^{3}$
EOR5 b	$1^{8}2D^{2}$	HKR1 c	$3D^{7}1^{3}$
EOR5 b-c	$1^{8}2D^{2}$	HKR1/S c	4P
EOR5 c	$1^{8}2D^{2}$	HKR1 c-d	$3D^{7}2T^{3}$
EOR5 c-d	$2T^{8}2D^{2}$	HKR1 d	$3D^{7}3T^{3}$
EOR5 d	3T	HKR1 e-f	5T
EOR5 e-f	5T	HKR2 b	$3D^{8}6W_{N}^{2}$
EOR10 d	$3T^{6}4E^{4}$	HKR3 b-c	3D

continued . . .

Table 2. Continued.

Map Unit	Soil Rating	Map Unit	Soil Rating
HKR3/c	3D	KLM3/c	$3D^{7}6^{W^{3}}_{N}$
HKR3/c-d	4^{T}_{D}	KLM4/b	3D
HKR3/d-e	5T	KLM4/b-c	3D
HKR3/e-f	6T	KLM4/c	3D
HKR1/b	$3D^{7}1^{3}$	KLM4/c-d	3D
HKR1/S/b-c	4P	KLM4/d	4^{T}_{D}
IRM1/b	3M	MET1/b	3M
IRM1/c	3M	MET1/b-c	3M
IRM1/d	3M	MET1/c	3M
IRM1/e	5^{M}_{T}	MET1/c-d	3M
IRM2/b	3M	MET1/d-e	4^{M}_{T}
IRM2/c	3M	PTE1/c-d	3T
IRM2/b	3M	PTE1/c-e	4T
IRM3/b	2M	PTE1/c-f	5T
KLM1/b	3D	PTE1/d	4T
KLM2/b	3D	PTE1/d-e	5T
KLM3/b	$3D^{7}6^{W^{3}}_{N}$	PTE1/e	5T

continued . . .

Table 2. Concluded.

Map Unit	Soil Rating	Map Unit	Soil Rating
PTE1 e-f	6T	TOL1 b-c	$5D^{8}3D^{2}$
PTE1 f	6T	TOL1 c	$5D^{8}3D^{2}$
RB1 d-g	6T	TOL1 c-d	$5D^{8}3D^{2}$
RB1 e-h	6T	TOL1 d	$5D^{8}3D^{2}$
RED1 b	4M	TOL1 d-e	5^{D}_{T}
RED1 c	4M	TOL3 b-c	$5D^{7}3D^{3}$
RED1 d	4M	TOL3 c	$5D^{7}3D^{3}$
RED2 c	4M	TOL3-SUL1 c	$5D^{7}3M^{3}$
SUL1 b-c	3M	TOL4 b	5D
SUL1 c	3M	TOL4 b-c	5D
SUL1 d	3M	TOL4 c	5D
SUL1 d-e	4^{M}_{T}	TOL1 d	5D
SUL1 f	5T	TOL4 d-e	5^{D}_{T}
SUL1 f-g	6T	WWT1 b	4M
TOL1 b	$5D^{8}3D^{2}$		

6. REFERENCES

American Society of Agronomy. 1965. Methods of soil analysis. Agronomy 9(2):890-901.

Association of Official Agricultural Chemists. 1955. Official method of analysis, 8th ed. Washington, DC.

Agricultural Rehabilitation and Development Act (ARDA). 1965. The Canada land inventory, soil capability classification for agriculture. Department of Forestry, Canada.

Bowser, W.E. 1967. Agro-climatic areas of Alberta. Surveys and Mapping Branch, Department of Energy, Mines, and Resources, Ottawa.

Bowser, W.E., R.L. Erdman, F.A. Wyatt, and J.D. Newton. 1947. Soil survey of Peace Hills sheet. Alberta Soil Survey Report Number 14.

Bowser, W.E., T.W. Peters, and J.D. Newton. 1951. Soil survey of Red Deer sheet. Alberta Soil Survey Report Number 16.

Canada Soil Survey Committee, Subcommittee on Soil Classification. 1978. The Canadian system of soil classification. Department of Agriculture Publication 1646, Supply and Services Canada, Ottawa, Ontario. 164 pp.

Doughty, J.L. 1941. Advantages of a soil paste for routine pH determinations. Scientific Agriculture, Volume 22, pp. 135-138.

Toogood, J.A. 1958. A simplified textural classification diagram. Canadian Journal of Soil Science, Volume 38. pp. 54-55.

Toogood, J.A. and T.W. Peters. 1953. Comparison of methods of mechanical analysis of soils. Canadian Journal of Agricultural Science, Volume 33. pp. 159-171.

United States Department of Agriculture. 1954. Diagnosis and improvement of saline and alkali soils. United States Department of Agriculture, Agricultural Handbook 60.

7. APPENDICES

7.1 DEFINITION OF SOIL HORIZON SYMBOLS PERTINENT TO THE BATTLE RIVER AREA (AFTER CANADA SOIL SURVEY COMMITTEE 1978)

Organic Horizons

Organic horizons are found at the surface of some mineral soils, or at any depth beneath the surface in buried soils, or overlying geologic deposits. Such horizons contain more than 17% organic carbon by weight. Two groups are recognized:

1. O - this is an organic horizon mainly developed from mosses, rushes, and woody material:
   - (a) Of - the fibric horizon is the least decomposed of all the organic soil materials. It contains large amounts of well preserved fiber that are readily identifiable as to botanical origin;
   - (b) Om - the mesic horizon is in an intermediate stage of decomposition, with intermediate amounts of fiber and moderate bulk density and water-holding capacity;
   - (c) Oh - the humic horizon contains the most highly decomposed organic soil materials. It has the least amount of fiber, the highest bulk density, and the lowest water-holding capacity.
2. L-F-H - these organic horizons develop primarily from leaves, twigs, woody materials, and a minor component of mosses:
   - (a) L - this is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible;

(b) F - this is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures, in part, are difficult to recognize;

(c) H - this is an organic horizon characterized by an accumulation of decomposed matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification, chiefly through the action of organisms.

Master Mineral Horizons and Layers

Mineral horizons are those that contain less organic carbon than is specified for organic horizons.

1. A - this is a mineral horizon formed at or near the surface in the zone of removal of materials in solution or suspension, or in the zone of maximum in situ accumulation of organic matter, or both. Included are:
   (a) horizons in which organic matter has accumulated as a result of biological activity (Ah);
   (b) horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of these (Ae).
2. B - this is a mineral horizon characterized by one or more of the following:
   (a) an enrichment in silicate clay (Bt);
   (b) an enrichment in sesquioxides (Bf);
   (c) an alteration by hydrolysis, reduction, or oxidation to give a change in colour or structure from horizons above or below (Bm and Bg);
   (d) a columnar structure and a significant amount of exchangeable sodium (Bn).

3. C - this is a mineral horizon comparatively unaffected by the pedogenic processes operative in A and B, excepting the process of gleying (Cg) and the accumulation of calcium and/or magnesium carbonates (Ck) and more soluble salts (Cs, Csa).
4. R - this is a consolidated bedrock layer that is too hard to break with the hands (3 Mohs scale) or dig with a spade when moist, and that does not meet the requirements of a C horizon. The boundary between the R layer and any overlying unconsolidated material is called a lithic contact.

b - a buried soil horizon;

ca - a horizon of secondary carbonate enrichment in which the concentration of lime exceeds that in the un-enriched parent material;

e - a horizon characterized by the removal of clay, iron, aluminum, or organic matter alone, or in combination. When dry, it is higher in colour value by one or more units than underlying B horizon. It is used with A (Ae, Ahe);

g - a horizon characterized by grey colours, or prominent mottling, or both, indicating permanent or periodic intense reduction. Chromas of the matrix are generally one or less;

h - a horizon enriched with organic matter. When used with A it must show one Munsell unit of value darker than the horizon below, or have 0.5% more organic carbon than the parent material (IC). It contains less than 17% organic carbon by weight;

j - used as a modifier of suffixes e, f, g, and n, and to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be placed to the right and adjacent to the suffix it modifies;

k - denotes the presence of carbonate as indicated by visible effervescence when dilute HCl is added;

m - a horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in colour or structure, or both;

n - a horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. When used with B it must also have the following properties: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistency when dry;

p - a horizon disturbed by human activities such as cultivation, logging, and habitation. It is used with A and O;

s - a horizon with salts, including gypsum, whic may be detected as crystals or veins, as surface crusts or salt crystals, by distressed crop growth, or by the presence c salt-tolerant plants. It is commonly used with C and k (Csk);

sa - a horizon with secondary enrichment of salts more soluble than calcium and magnesium carbonates, in which the concentration of salts exceeds that present in the un-enrich parent material. The conductivity of the saturation extract must be at least 4 mmhos/cm and must exceed that of the C horizon by at least one-third. The horizo is 10 cm or more thick;

t - an illuvial horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), with B and n (Bnt), and so on;

Bt - a Bt horizon is one that contains illuvial layer-lattice clays. It forms below an eluvial horizon, but may lie at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than IC. It has the following properties:

(a) if any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizon, as follows:

(i) if any part of the eluvial horizon has less than 15% total clay in the fine earth fraction, the Bt horizon must contain at least 3% more clay;

(ii) if the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more;

(iii) if the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon.

7.2 CHEMICAL AND PHYSICAL ANALYSES, MORPHOLOGICAL AND ANALYTICAL DATA FOR REPRESENTATIVE SOIL PROFILES

The analytical procedures used in the various determinations were:

1. Reaction (pH) - soil paste method of Doughty; a Coleman glass electrode was used (Doughty 1941);
2. Exchange capacity - ammonium acetate method by displacement of ammonium chloride (American Society of Agronomy 1965);
3. Exchangeable cations - calcium, magnesium, sodium, and potassium were determined by atomic absorption spectrophotometry (Association of Official Agricultural Chemists 1955);
4. Particle size analysis - pipette method of Kilmer and Alexander as modified by Toogood and Peters (1953);
5. Electrical conductivity - determined according to the procedure outlined in United States Department of Agriculture Handbook 60; the saturation extract was obtained by suction and the conductivity measured with a direct-reading solu-bridge (United States Department of Agriculture 1954).

7.2.1 Detailed Descriptions and Analyses of the Soils

Thirty-seven soil profiles were described in detail and sampled for laboratory analyses. Descriptions and accompanying analyses representing the major soils of the area are presented in this section of the report. It should be noted that each description and the accompanying analytical data represent a point source, therefore, the information should be used accordingly.

A DESCRIPTION OF SOIL PROFILE COMMON TO THE ALLUVIUM 1 SOIL UNIT

Soil Unit: AVM 1
Classification: Orthic Dark Brown Chernozem
Location: SE 28-40-15-W4
Topography: Undulating
Drainage: Moderately well drained
Parent Material: Alluvial

Horizon

Ah 0 - 15 cm; very dark grayish brown (10YR 3/2 m*) sandy loam to loam; moderate, fine granular; friable; plentiful, fine and very fine roots; abrupt smooth boundary.

Bm1 15 - 31 cm; dark yellowish brown (10YR 4/4 m) sandy loam; weak, fine subangular blocky to single grain; friable to very friable; few, fine and very fine roots; clear, wavy boundary.

Bm2 31 - 55 cm; dark brown (10YR 3/3 m) sandy loam, weak, fine subangular blocky to single grain; friable to very friable; few, fine and very fine roots; abrupt, smooth boundary.

BC1 55 - 79 cm; dark yellowish brown (10YR 4/4 m) sandy loam to loamy sand; single grain; friable to very friable; few, very fine roots; clear, wavy boundary.

BC2 79 - 120 cm; brown to dark brown (10YR 4/3 m) sandy loam; single grain, friable to very friable.

Cca at 120 cm; brown to dark brown (10YR 4/3 m) sandy loam; friable to very friable.

m* - moist color

Analyses of an Alluvium Soil Profile (AVM 1)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%SI	%C	
Ah	0-15	6.0	-	-	-	-	-	-	21.5	0.24	1.29	16.50	2.91	61	28	11	SL
Bm1	15-31	6.5	-	-	-	-	-	-	16.8	0.18	0.43	14.79	2.89	67	19	14	SL
Bm2	31-55	6.5	-	-	-	-	-	-	17.4	0.18	0.44	15.78	3.14	58	28	14	SL
BC	55-79	6.8	-	-	-	-	-	-	9.1	0.22	0.37	8.01	1.72	82	10	8	LS
BC2	79-120	7.0	-	-	-	-	-	-	14.4	0.15	0.56	15.89	2.46	72	18	10	SL
Cca	120 +	7.6	-	-	-	-	-	-	19.7	0.17	0.53	29.37	4.02	76	16	8	SL

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE BIG KNIFE I SOIL UNIT

Soil Unit: BKF I
Classification: Dark Brown Solodized Solonetz
Location: SE 28-40-15-W4
Topography: Undulating
Drainage: Imperfectly to moderately well drained
Parent Material: Residual

Horizon

Ah 0 - 3 cm; dark brown (7.5YR 3/2 m) silt loam; very weak, granular; firm; plentiful, fine, very fine and micro roots; clear, smooth boundary.

Ae 3 - 5 cm; very dark grayish brown (2.5Y 3/2 m) silt loam to silty loam to silty clay loam; very weak platy; firm; few fine, plentiful, very fine, few, micro roots; clear, smooth boundary.

Bnt 5 - 19 cm; very dark grayish brown (10YR 3/2 m) silty clay to clay; strong, fine columnar breaking to medium to fine, sub-angular blocky; very firm to hard; few, very fine exped roots; clear, wavy boundary.

BC 19 - 28 cm; very dark grayish brown (2.5Y 3/2 m) silty clay to clay; very firm to hard; few, very fine and exped micro roots; clear, wavy boundary.

Csaca at 28 cm; dark brown (10YR 3/3 m) silty clay; very firm to hard.

Analyses of a Big Knife Soil Profile (BKF I)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%SI	%C	
Ah	0-3	6.4	-	-	-	-	-	-	30.6	2.25	1.64	15.43	4.23	20	54	26	SIL
Ae	3-5	6.0	-	-	-	-	-	-	19.7	3.03	0.92	9.07	3.54	19	62	19	SIL
Bnt	5-19	7.8	1.9	7.0	2.5	19.7	16.3	9.04	33.3	6.62	1.10	15.92	8.40	9	48	43	SIC
BC	19-28	7.5	2.1	8.5	3.0	21.3	18.5	8.88	40.9	11.48	1.18	25.02	12.31	4	42	54	SIC
Csaca	28 +	7.4	-	-	-	-	-	-	44.4	12.99	1.13	28.67	13.09	3	45	52	SIC

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE CORDEL 1 SOIL UNIT

Soil Unit: COR 1
Classification: Humic Luvic Gleysol
Location: NE 5-41-15-W4
Topography: Depressional to very gently sloping
Drainage: Poorly drained
Parent Material: Till

Horizon

H 0 - 6 cm; dark brown (7.5YR 3/2 m) well decomposed grass litter; many, coarse to medium roots; clear wavy boundary.

Ah 6 - 18 cm; black (2.5Y 2/0 m) silty clay loam; moderate, fine granular; friable; many medium to fine and very fine roots; abrupt, smooth boundary.

Aeg 18 - 34 cm; light gray to gray (10YR 6/1 m) very fine sandy loam; common, medium, reddish brown (7.5YR 6/8 m) mottles; strong, medium to coarse platy; friable to firm; few, very fine roots; clear wavy boundary.

Btg 34 - 54 cm; light gray to gray (10YR 6/1 m) clay loam to clay; many, reddish yellow (5YR 6/8 m) mottles; moderate, fine granular to weak, subangular blocky; firm; clear, wavy boundary.

BCg 54 - 110 cm; light gray to gray (10YR 6/1 m) silty clay loam to clay loam; many, reddish yellow (5YR 6/8 m) mottles; moderate, fine granular to weak, subangular blocky; firm; clear, wavy boundary.

Ccag at 110 cm; very dark grayish brown (2.5Y 3/2 m) loam; many, yellowish brown (10YR 5/6 m) mottles; moderate, fine granular to weak, subangular blocky.

Analyses of a Cordel Soil Profile (COR 1)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%SI	%C	
H	0-6	6.3	-	-	-	-	-	-	22.8	0.36	2.39	13.17	3.65	12	59	29	SICL
Ah	6-18	6.3	-	-	-	-	-	-	19.5	0.33	2.27	11.14	3.09	15	56	29	SICL
Aeg	18-34	6.5	-	-	-	-	-	-	4.1	0.15	0.56	3.04	1.16	28	57	15	SIL
Btg	34-54	6.5	-	-	-	-	-	-	15.3	0.34	1.27	12.32	5.59	20	40	40	CL
BCg	54-110	6.6	0.4	1.8	1.1	0.6	2.8	0.50	15.3	0.33	1.12	12.80	6.10	25	40	35	CL
Ccag	110 +	7.4	0.5	3.5	1.6	1.3	2.4	0.82	12.9	0.29	0.81	10.73	5.10	40	39	21	L

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE ELNORA 1 SOIL UNIT

Soil Unit: EOR 1
Classification: Orthic Black Chernozem
Location: SW 33-40-15-W4
Topography: Gently undulating
Drainage: Well drained
Parent Material: Till

Horizon

Ap 0 - 14 cm; very dark grayish brown (10YR 3/2 m) loam; moderate, fine granular, friable; plentiful, fine and very fine roots; many, very fine pores; slightly stony; abrupt, smooth boundary.

AB 14 - 25 cm; dark brown (10 YR 4/3 m) clay loam; strong, fine and medium, subangular blocky; friable; plentiful, fine and very fine roots; many, very fine pores; slightly stony; abrupt, smooth boundary.

Bt 25 - 37 cm; dark grayish brown (10YR 4/2 m) clay; moderate, medium, prismatic breaking to strong, fine subangular blocky; friable to firm; few, very fine roots; many, very fine pores; slightly stony; clear wavy boundary.

BC 37 - 53 cm; dark grayish brown (10YR 4/2 m) clay loam; moderate, fine subangular blocky; firm; very few, very fine roots; common, very fine pores; slightly stony; abrupt, smooth boundary; pH 7.5.

Cca 53 - 78 cm; brown (10YR 5/3 m) loam; slightly stony.

Ck 78 + cm; loam; slightly stony.

Analyses of an Elnora Soil Profile (EOR 1)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%SI	%C	
Ap	0-14	6.8	0.7	4.4	1.7	1.0	-	0.57	18.1	0.05	1.26	19.28	3.33	38	44	18	L
AB	14-25	7.1	0.6	4.6	2.0	1.2	-	0.66	21.3	0.10	1.13	20.22	2.61	25	46	29	CL
Bt	25-37	7.2	0.5	3.3	1.4	1.2	-	0.78	24.0	0.25	0.98	20.53	6.66	13	36	51	C
BC	37-53	7.5	2.5	24.0	10.7	4.1	-	0.98	15.1	0.49	0.87	16.00	4.61	30	40	30	CL
Cca	53-78	7.7	3.1	27.0	14.0	9.6	-	2.12	11.0	1.10	0.66	36.06	7.23	42	37	21	L
Ck	78 +	7.7	3.2	29.5	20.2	8.7	-	1.74	12.5	1.13	0.85	43.09	8.71	37	37	26	L

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE FLAGSTAFF SOIL UNIT

Soil Unit: FST 1
Classification: Solonetzic Dark Brown Chernozem
Location: NW 16-40-15-W4
Topography: Gently undulating
Drainage: Moderately well drained
Parent Material: Till

Horizon

Ap 0 - 16 cm; very dark grayish brown (10YR 3/2 m) loam; moderate, fine granular and subangular blocky; friable; abundant, very fine roots; many, fine and very fine pores; few coarse fragments; abrupt, smooth boundary.

Ahe 16 - 23 cm; dark brown (10YR 4/3 m) loam; moderate, medium subangular blocky; friable to firm; plentiful, very fine roots; many, fine pores; few, coarse fragments; gradual, wavy boundary.

Ae 23 - 28 cm; brown (10YR 5/3 d*) silt loam; weak fine subangular blocky; slightly hard; few, very fine roots; many, fine pores; few, coarse fragments; gradual, wavy boundary.

AB 28 - 42 cm; brown (10YR 5/3 d) loam; strong, medium angular blocky; hard; few, very fine roots; many, very fine pores; few, coarse fragments; clear, wavy boundary.

Bnjtj 42 - 53 cm; dark brown (10YR 3/3 m) clay loam; weak medium columnar to strong, medium, angular blocky; hard; few, very fine roots; few, very fine pores; few, coarse fragments; gradual, wavy boundary.

BC 53 - 73 cm; yellowish brown (10YR 5/4 m) loam; firm, few, coarse fragments; gradual, wavy boundary.

Ck 73 + cm; yellowish brown (10YR 5/4 m) clay loam.

*dry color

Analyses of a Flagstaff Soil Profile (FST 1)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%Si	%C	
Ap	0-16	6.1	0.7	2.3	1.7	2.4	-	1.69	17.5	0.31	0.94	11.06	3.59	38	46	16	L
Ahe	16-23	6.6	-	-	-	-	-	-	13.7	0.57	0.36	10.69	3.79	35	48	17	L
Ae	23-28	6.3	-	-	-	-	-	-	10.6	0.59	0.34	5.22	3.23	34	52	14	SIL
AB	28-42	6.5	0.4	1.1	0.63	3.8	-	4.08	11.9	0.78	0.40	4.75	9.68	36	43	21	L
Bnjtj	42-53	6.9	0.6	0.8	0.8	4.5	-	5.00	14.3	1.83	0.46	4.84	10.96	37	36	27	CL
BC	53-73	7.8	1.4	1.3	2.9	10.4	-	7.18	14.0	2.29	0.62	4.44	14.55	39	35	16	L
Ck	73 +	8.0	2.8	21.3	15.1	12.8	-	4.27	11.6	3.13	0.55	20.09	15.32	42	24	34	CL

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE FOREMAN I SOIL UNIT

Soil Unit: FHN 1
Classification: Gleyed Black Solonetz
Location: NW 22-40-16
Topography: Gently undulating
Drainage: Imperfectly to poorly drained
Parent Material: Till

Horizon

Ah 0 - 5 cm; very dark gray (10YR 3/1 m) loam; weak, fine granular; friable; abundant, fine and very fine roots; many fine and very fine pores; slightly stony; abrupt, smooth boundary.

Bn 5 - 13 cm; very dark gray (10YR 3/1 m) inped and light olive brown (2.5Y 5/4 m) loam; clay loam; strong, medium columnar; firm, few, very fine roots; few, fine pores; slightly stony; gradual, smooth boundary.

BCgj 13 - 17 cm; dark gray (10YR 4/1 m) inped and light olive brown (2.5Y 5/4 m) exped, loam; few, fine faint mottles; fine sub-angular blocky; firm; few, very fine roots; few, fine pores; slightly stony; abrupt, smooth boundary.

Csakgj 17 - 25 cm; light olive brown (2.5Y 5/4 m) loam; few, fine faint mottles; firm; few, very fine roots; slightly stony.

Cskgj 25 + cm; light olive brown (2.5Y 5/4 m) loam; few, fine faint mottles; firm.

Analyses of a Foreman Soil Profile (FHN 1)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%SI	%C	
Ah	0-5	6.9	-	-	-	-	-	-	20.9	3.54	0.64	12.88	4.92	44	43	13	L
Bn	5-13	7.5	3.8	3.9	5.6	44.3	-	20.33	18.7	8.83	0.56	17.63	11.73	44	32	24	L
BCgj	13-17	7.8	8.6	21.8	27.1	102.6	-	20.75	13.1	10.59	0.52	32.91	11.01	41	34	25	L
Csakgj	17-25	7.7	10.2	21.0	28.0	132.2	-	26.70	11.0	11.41	0.44	54.66	7.94	42	36	22	L
Cksgj	25 +	8.0	6.5	4.6	11.02	80.0	-	28.63	11.6	10.72	0.39	30.44	7.23	42	36	22	L

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE HEISLER 1 SOIL UNIT

Soil Unit: HER 1
Classification: Solonetzic Black Chernozem
Location: SE 33-40-15-4
Topography: Gently undulating
Drainage: Moderately well to well drained
Parent Material: Till

Horizon

Ah 0 - 20 cm; black (10YR 2/1 m) loam; moderate, fine granular; friable; few, medium and abundant, fine and very fine roots; some pebbles; clear, wavy boundary.

Ahe 20 - 30 cm; brown to dark brown (10YR 4/3 m) silt loam; weak, fine platy to weak, medium granular; friable; abundant, fine and very fine roots; some pebbles; clear, wavy boundary.

Ae 30 - 37 cm; brown (10YR 5/3 m) fine sandy loam to silt loam; weak, medium platy; friable; few, fine, abundant, very fine roots; some pebbles; abrupt, smooth boundary.

Bnjtj 37 - 55 cm; very dark grayish brown exped (10YR 3/2 m) with dark yellowish brown matrix (10 YR 4/4 m) clay loam; weak to moderate, medium columnar to moderate, medium, subangular blocky; firm; few, very fine, very few, fine roots along column faces; some pebbles; clear, wavy boundary.

BC 55 - 69 cm; dark yellowish brown (10YR 4/4 m) loam; moderate, medium blocky; firm; some pebbles; clear, wavy boundary.

Ck 69 - 84 cm; olive brown (2.5Y 4/4 m) loam; clear, irregular boundary.

Csk at 85 cm; olive brown (2.5Y 4/4 m) loam; some pebbles.

Analyses of a Heisler Soil Profile (HER 1)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%Si	%C	
Ah	0-20	6.1	-	-	-	-	-	-	34.5	0.01	1.64	13.86	5.26	29	45	26	L
Ahe	20-30	6.2	-	-	-	-	-	-	19.5	0.01	0.84	6.31	3.95	20	59	21	SIL
Ae	30-37	5.9	-	-	-	-	-	-	15.3	0.05	0.47	3.74	4.24	19	63	18	SIL
Bnjtj	37-55	6.3	0.9	2.5	0.5	1.2	2.6	0.98	25.6	0.34	0.71	5.43	11.11	28	41	31	CL
BC	55-69	6.8	0.8	1.6	0.4	1.3	4.7	1.3	23.6	0.36	0.69	5.32	11.75	34	40	26	L-CL
Cca	69-84	7.4	0.9	4.5	1.2	0.9	5.6	0.54	20.3	0.35	0.49	36.89	8.03	37	40	23	L
Csk	85 +	7.8	2.6	8.2	6.6	1.4	9.7	0.52	18.6	0.30	0.43	66.11	5.83	38	38	24	L

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE HALKIRK I SOIL UNIT

Soil Unit: HKR 1
Classification: Dark Brown Solodized Solonetz
Location: NW 16-40-15-W4
Topography: Gently undulating
Drainage: Moderately well drained
Parent Material: Till

Horizon

Ap 0 - 13 cm; very dark grayish brown (10YR 3/2 m) loam; sandy loam; weak, fine subangular blocky; friable; plentiful, very fine roots; many, fine pores; few coarse fragments; gradual, smooth boundary.

Ahe 13 - 20 cm; dark grayish brown (10YR 4/2 m) silt loam; moderate, medium subangular blocky; friable; plentiful, very fine roots; many, very fine pores; few coarse fragments, abrupt, smooth boundary.

Bnt 20 - 34 cm; dark grayish brown (10YR 4/2 m) silt loam with very dark gray (10YR 3/1 m) stains; strong, coarse columnar; firm; plentiful, very fine roots between peds; few coarse fragments; gradual, smooth boundary.

BC 34 - 43 cm; dark grayish brown (10YR 4/2 m) loam, strong medium subangular blocky; firm; common, very fine pores; few coarse fragments; clear, smooth boundary.

Csa 43 - 63 cm; dark yellowish brown to yellowish brown (10YR 4/4-5/4 m) clay loam; weak effervescence; few coarse fragments; gradual, smooth boundary.

Csk 63 - 73 + cm; dark yellowish brown to yellowish brown (10YR 4/4 - 5/4 m) loam; weak effervescence; few coarse fragments.

Analyses of a Halkirk Soil Profile (HKR 1)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%SI	%C	
Ap	0-13	6.0	0.5	0.9	0.4	3.2	-	3.97	12.9	0.69	0.69	5.13	0.92	35	49	16	L-SIL
Ahe	13-20	6.2	3.8	4.7	6.6	41.0	-	17.25	15.4	6.51	0.23	5.25	2.46	29	52	19	SIL
Bnt	20-34	6.6	4.0	2.8	5.8	50.4	-	24.30	15.4	9.10	0.29	4.78	7.38	34	41	25	SIL-L
BC	34-43	7.1	4.8	2.1	4.3	33.2	-	18.56	13.4	8.97	0.30	3.44	12.50	38	36	26	L-CL
Csa	43-63	7.4	10.9	21.0	41.1	137.4	-	24.66	12.5	11.55	0.30	21.09	12.24	38	34	28	CL
Csk	63-73+	7.6	10.8	21.5	39.4	139.1	-	25.21	11.0	11.69	0.46	15.88	13.01	39	35	26	L-CL

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE IRMA I SOIL UNIT

Soil Unit: IRM 1
Classification: Orthic Black Chernozem intergrade to Gleyed Orthic Black
Location: NW 21-40-16-4
Topography: Gently undulating
Drainage: Moderately well to imperfectly drained
Parent Material: Glaciofluvial veneer over till

Horizon

Ah 0 - 25 cm; very dark grayish brown (10YR 3/2 m) sand; weak, fine granular; friable; plentiful, medium, fine, and very fine, oblique and vertical roots; abrupt, smooth boundary.

Bm 25 - 55 cm; dark brown (10YR 4/3 m) to dark yellowish brown (10YR 4/4 m) sand; single grain, very friable; many, fine and very fine, vertical and oblique roots; clear, wavy boundary.

BCgj 55 - 85 cm; dark grayish brown (10YR 4/2 m) sand; common, dark reddish brown (5YR 3/4 m) mottles; single grain; very friable; common very fine and few fine vertical roots; clear, wavy boundary.

Cgj 85 - 110 cm; dark grayish brown (10YR 4/2 m) to dark brown (10YR 4/3 m) sand; common to plentiful, dark reddish brown (5YR 3/4 m) mottles; single grain; very friable; very few, fine and very fine vertical roots; clear, wavy boundary.

IICcag at 110 cm, dark grayish brown (2.5Y 4/2 m) sandy loam; plentiful, strong brown (7.5YR 5/6 m) mottles.

Analyses of Irma Soil Profile (IRM 1)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%SI	%C	
Ah	0-25	6.3	-	-	-	-	-	-	6.2	0.01	0.52	0.65	0.76	90	7	3	S
Bm	25-55	6.0	-	-	-	-	-	-	3.8	0.01	0.26	3.71	0.70	90	8	2	S
BCgj	55-85	6.4	-	-	-	-	-	-	2.5	0.01	0.15	2.61	0.48	92	6	2	S
Cgj	85-110	7.0	0.2	6.3	2.0	1.1	4.3	0.54	2.2	0.01	0.14	1.98	0.46	91	8	1	S
IICcag	110 +	7.8	0.4	4.4	1.5	0.9	6.0	0.53	12.5	0.78	0.45	12.41	3.10	56	25	19	SL

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE KILLAM 1 SOIL UNIT

Soil Unit: KLM 1
Classification: Black Solodized Solonetz
Location: NE 2-41-16-W4
Topography: Gently undulating
Drainage: Moderately well to well drained
Parent Material: Till

Horizon

Ap 0 - 13 cm; black (2.5Y 2/0) silt loam; moderate, fine granular, friable; few, medium and common, fine roots; some small pebbles; abrupt, smooth boundary.

Ae 13 - 18 cm; brown to dark brown (7.5YR 4/4) silt loam; weak, medium platy; friable, few, fine and very fine roots; some small pebbles; abrupt, wavy boundary.

Bnt 18 - 33 cm; dark yellowish brown matrix (10YR 4/4) with very dark gray (10YR 3/1) organic stained loam; very strong, coarse columnar to strong, coarse angular blocky; very firm; very few, very fine roots along columnar faces; some small pebbles; clear, wavy boundary.

BC 33 - 45 cm; yellowish brown (10YR 5/6) loam; weak to moderate subangular blocky; firm to very firm; some small pebbles; clear, irregular boundary.

Csa 45 - 59 cm; dark yellowish brown (10YR 4/4) loam; some small pebbles; clear, wavy boundary.

Csaca at 59 cm; dark grayish brown (2.5Y 4/2) loam.

Analyses of a Killam Soil Profile (KLM 1)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%Si	%C	
Ap	0-13	6.6	-	-	-	-	-	-	26.8	0.48	0.95	11.36	2.76	35	58	7	SiL
Ae	13-18	6.2	-	-	-	-	-	-	12.7	1.06	0.22	4.18	2.89	35	54	11	SiL
Bnt	18-33	7.7	2.2	3.5	1.5	13.2	18.0	8.31	21.8	3.92	0.38	4.40	9.74	30	48	22	L
BC	33-45	7.5	3.1	9.6	4.2	17.8	21.3	6.77	17.1	3.46	0.33	4.36	7.65	43	40	17	L
Csa	45-59	8.0	8.5	21.4	23.6	88.3	209	18.59	22.7	5.41	0.46	36.04	9.53	39	43	18	L
Csaca	59 +	8.1	8.2	19.6	26.4	96.5	215	20.11	19.2	8.90	0.43	42.65	11.69	41	41	18	L

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE METISKO 1 SOIL UNIT

Soil Unit: MET 1
Classification: Orthic Dark Brown Chernozem
Location: NW 34-39-16-W4
Topography: Gently undulating
Drainage: Imperfect
Parent Material: Glaciofluvial

Horizon

Ah 0 - 14 cm; very dark gray (10YR 3/1 m) loamy sand; weak, fine granular; friable; abundant, fine and very fine roots; many, fine pores; clear, wavy boundary.

Ahe 14 - 24 cm; very dark grayish brown (10YR 3/2 m) sandy loam; weak, fine subangular blocky, friable; plentiful, fine and very fine roots; many, fine pores; clear, wavy boundary.

Bm 24 - 34 cm; dark brown (10YR 4/3 m) sandy loam; single grain friable; few, fine and very fine roots; many, fine pores, gradual, smooth boundary.

BC 34 - 79 cm; light brownish gray (2.5Y 6/2 m) sand; few, medium, distinct dark yellowish brown (10YR 4/4 m) mottles; single grain friable; very few roots; many, fine pores; clear, smooth boundary.

Ck at 79 cm; grayish brown (2.5Y 5/2 m) loamy sand; single grain.

Analyses of a Metisko Soil Profile (MET 1)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%Si	%C	
Ah	0-14	5.6	-	-	-	-	-	-	7.2	1.22	0.12	5.13	0.72	80	19	1	LS
Ahe	14-24	6.2	-	-	-	-	-	-	5.7	1.24	0.08	4.97	1.13	70	24	6	SL
Bm	24-34	6.2	-	-	-	-	-	-	4.4	0.61	0.08	3.84	0.67	68	28	4	SL
BC	34-79	6.7	0.4	6.9	2.8	1.3	3.9	0.59	1.6	0.32	0.06	1.72	0.05	83	17	-	LS
Ck	79 +	7.9	0.5	5.0	2.1	1.4	5.2	0.74	5.0	1.66	0.16	4.28	0.92	80	12	8	LS

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE PAINTEARTH I SOIL UNIT

Soil Unit: PTE I
Classification: Orthic Dark Brown Chernozem
Location: NW 21-40-15-W4
Topography: Gently undulating
Drainage: Moderately well drained
Parent Material: Residual (shale)

Horizon

Ah1 0 - 20 cm; dark reddish brown (5YR 3/4 m) loam; moderate, fine granular; friable, common, coarse and medium roots and plentiful, fine and very fine roots; clear, wavy boundary.

Ah2 20 - 50 cm; dark reddish brown (2.5YR 2/4 m) loam; moderate fine granular; friable; few, fine and plentiful, very fine roots; few pebbles; clear, wavy boundary.

Bm 50 - 70 cm; dark red (2.5YR 3/6 m) clay loam; weak to moderate; fine subangular blocky; friable; very few, fine roots; clear, wavy boundary.

BC 70 - 83 cm; strong brown (7.5YR 5/6 m) silt loam; friable, clear, wavy boundary.

Ccal 83 - 99 cm; yellowish red (5YR 4/6 m) weathered shale fragments; clear, wavy boundary.

Cca2 at 99 cm; yellowish brown (10YR 5/8 m) shale fragments.

Analyses of a Paintearth Soil Profile (PTE I)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%SI	%C	
Ah1	0-20	6.1	-	-	-	-	-	-	3.6	0.20	1.20	22.70	4.27	40	38	22	L
Ah2	20-50	6.2	-	-	-	-	-	-	28.0	0.39	0.85	22.51	5.64	40	37	23	L
Bm	50-70	6.4	-	-	-	-	-	-	30.3	1.73	1.36	22.14	7.30	22	41	37	CL
BC	70-83	6.4	-	-	-	-	-	-	30.3	1.15	2.14	19.29	6.09	20	54	26	SIL
Ccal	83-99	7.6	-	-	-	-	-	-	8.8	1.60	1.83	30.57	2.03	79	21	-	LS
Cca2	99 +	7.9	-	-	-	-	-	-	1.2	0.36	0.17	3.92	0.37	73	26	1	LS

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE RED WILLOW I SOIL UNIT

Soil Unit: RED 1
Classification: Orthic Black Chernozem
Location: NW 29-40-16-W4
Topography: Gently undulating
Drainage: Moderately well to well drained
Parent Material: Sandy glaciofluvial veneer overlying till

Horizon

Ah1 0 - 15 cm; very dark gray (10YR 3/1 m) loamy sand; weak, fine subangular blocky; friable; abundant, medium and fine roots; many, fine pores; diffuse, smooth boundary.

Ah2 15 - 44 cm; very dark gray to very dark grayish brown 10YR 3/1.5 m) loamy sand, weak subangular blocky; friable; plentiful, fine roots; many, fine pores; gradual, smooth boundary.

Bm 44 - 63 cm; yellowish brown (10YR 5/4 m) loamy sand; few, medium distinct dark yellowish brown (10YR 4/4 m) mottles; very weak subangular blocky; many, fine roots; gradual, wavy boundary.

C 63 - 93 cm; brown (10YR 5/3 m) sand; single grain; friable; few, fine roots; many, fine pores.

Ccagj 93 - 113 cm; brown (10YR 5/3 m) sand; few, medium distinct mottles; very few, fine roots; many, fine pores.

Analyses of a Red Willow Soil Profile (RED 1)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%Si	%C	
Ah1	0-15	6.2	-	-	-	-	-	-	11.5	0.09	0.69	6.31	1.33	87	9	4	S
Ah2	15-44	5.9	-	-	-	-	-	-	8.2	0.03	0.55	4.50	0.77	87	9	4	S
Bm	44-63	6.2	-	-	-	-	-	-	5.4	0.07	0.23	3.34	0.77	87	11	2	S
C	63-93	6.9	0.2	5.4	1.6	0.5	3.8	0.27	2.6	0.53	0.09	2.00	0.46	94	4	2	S
Ccagj	93-113	8.0	0.3	5.0	1.3	0.6	3.9	0.34	1.6	0.57	0.04	1.00	0.10	97	3	-	S

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE SULLIVAN LAKE 1 SOIL UNIT

Soil Unit: SUL 1
Classification: Orthic Dark Brown Chernozem intergrade to Dark Brown Solodized Solonetz
Location: NE 9-40-16-W4
Topography: Gently undulating
Drainage: Moderately well
Parent Material: Glaciofluvial/Till/Residual

Horizon

Ah 0 - 20 cm; very dark grayish brown (10YR 3/2 m) sandy loam; weak to moderate, fine granular; friable; many, medium fine and very fine roots; clear, wavy boundary.

Bm 20 - 50 cm; brown to dark brown (7.5YR 4/4 m) sandy loam to loamy sand, single grain; friable; many, fine and very fine roots; clear, wavy boundary.

Ae 50 - 55 cm; grayish brown (2.5Y 5/2 m) to light yellowish brown (2.5Y 6/3 m) loamy sand to sand; weak, fine platy; friable; few, very fine roots; abrupt, smooth boundary.

IIBnt 55 - 66 cm; yellowish brown inped (10YR 5/4 m) with brown to dark brown exped (10YR 4/3 - 3/3 m) sandy loam; strong, fine columnar; very firm; clear, wavy boundary.

IICsk at 66 cm; dark grayish brown (2.5Y 4/2 m) to olive brown (2.5Y 4/4 m) sandy loam; indurated.

Analyses of a Sullivan Lake Soil Profile (SUL 1)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%Si	%C	
Ah	0-20	6.5	-	-	-	-	-	-	14.7	0.01	0.37	10.47	1.84	63	28	9	SL
Bm	20-50	6.8	-	-	-	-	-	-	6.4	0.01	0.15	2.96	0.83	81	11	8	LS
Ae	50-55	6.3	-	-	-	-	-	-	2.1	0.06	0.10	1.59	0.34	84	14	2	S
IIBnt	55-66	7.9	2.0	3.4	1.2	19.6	23.5	6.05	7.6	2.69	0.44	5.98	1.46	78	10	12	SL
IICsk	66 +	7.6	3.1	12.1	6.9	38.3	63.8	12.4	7.4	2.71	0.37	33.04	1.69	79	10	11	SL

A DESCRIPTION OF A SOIL PROFILE COMMON TO THE TORLEA 1 SOIL UNIT

Soil Unit: TOL 1
Classification: Dark Brown Solodized Solonetz
Location: NW 33-39-15-W4
Topography: Nearly level
Drainage: Imperfectly drained
Parent Material: Residual (Sandstone)

Horizon

Ah 0 - 2 cm; dark grayish brown (10YR 4/2 m) to dark brown (10YR 4/3 m) loam; weak, fine granular; firm, abundant, fine and very fine roots; clear, wavy boundary.

Ae 2 - 7 cm; dark grayish brown (10YR 4/2 m) loam; moderate, medium platy; friable; common fine and very fine roots, abrupt, smooth boundary.

Bnt 7 - 15 cm; brown to dark brown inped (10YR 4/3 m) with very dark grayish brown exped (10YR 3/2 m) loam; strong, medium columnar; very firm; few, fine exped roots; clear, smooth boundary.

BC 15 - 27 cm; dark brown (10YR 3/3 m) to olive brown (2.5Y 4/4 m) sandy clay loam; strong, angular blocky; very firm; abundant, fine roots; clear, wavy boundary.

Csak at 27 cm; light olive brown (2.5Y 5/4 m) to olive brown (2.5Y 4/4 m) sandy loam to sandy clay loam; layered weathered sandstone; indurated.

Analyses of a Torlea Soil Profile (TOL 1)

Horizon	Depth (cm)	pH (H_2O)	E.C. (mS/cm)	Water Soluble Ions (me/l)				SAR	C.E.C. (me/100g)	Exchangeable Cations (me/100 g)				Particle Size Distribution			Texture
				Ca	Mg	Na	SO_4			Na	K	Ca	Mg	%S	%Si	%C	
Ah	0-2	6.0	-	-	-	-	-	-	18.7	0.82	1.55	7.84	2.08	36	42	22	L
Ae	2-7	5.7	-	-	-	-	-	-	8.0	1.69	0.29	4.24	1.29	48	33	19	L
Bnt	7-15	7.4	1.8	2.1	1.3	19.4	23.0	14.81	12.0	3.52	0.42	8.70	3.10	48	33	19	L
BC	15-27	7.8	2.4	2.4	1.2	21.3	26.2	15.78	15.8	4.87	0.44	12.56	4.44	55	18	27	SCL
Csak	27 +	8.3	5.2	12.8	6.9	44.8	71.3	14.27	8.0	4.17	0.34	12.78	2.58	74	14	12	SL

7.3 DEFINITION OF TERMS

Throughout this report descriptive terms are used repeatedly to describe features of significance within the map area. The following are definitions of some of these terms.

7.3.1 Soil Texture

Soil separates (particle size) on which textural classes are based.

Separates	Diameter (mm)
very coarse sand (VCS)	2.0 to 1.0
coarse sand (CS)	1.0 to 0.5
medium sand (MS) sand (S)	0.5 to 0.25
fine sand (FS)	0.25 to 0.10
very fine sand (VFS)	0.10 to 0.05
silt (Si)	0.05 to 0.002
clay (C)	less than 0.002
fine clay (FC)	less than 0.0002

Proportions of soil separates in various soil textural classes from Toogood (1958).

Sands are further divided according to the prevalence of different sized sand fractions. Medium and coarse sands may contain over 25% coarse sand, but not over 50% fine sand. Fine and very fine sands must contain over 50% of the respective fine sand fractions. The soil textural classes are grouped, according to the Canada Soil Survey Committee, as follows:

coarse textured sands, loamy sands
moderately coarse textured sandy loam, fine sandy loam
medium textured very fine sandy loam, loam, silt loam, silt
moderately fine textured sandy clay loam, clay loam, silty clay loam
fine textured sandy clay, silty clay, clay (40 to 60%)
very fine textured heavy clay (more than 60% clay)

7.3.2 Soil Structure and Consistence

Soil structure refers to the aggregation of the primary soil particles into compound particles, or clusters of primary particles, which are separated from adjoining aggregates by surfaces of weakness. The aggregates differ in grade of development (degree of distinctness) and this distinctness is classed as weak, moderate, or strong. The aggregates vary in size and are classed as very fine, fine, medium, coarse, or very coarse. They also vary in kind, that is, in the character of their faces and edges. The kinds mentioned in this report are:

single grain: loose (incoherent mass of individual particles as in sands);

blocky: faces rectangular and flattened, vertices sharply angular;

subangular blocky: faces subrectangular, vertices mostly oblique, or subrounded;

columnar: vertical edges near top of columns are not sharp (columns may be flat-topped, round-topped, or irregular);

granular: spheroidal, characterized by rounded vertices;

platy: horizontal planes more or less developed.

Soil consistence comprises the attributes of soil materials expressed by the degree and kind of cohesion and adhesion or by the resistance to deformation and rupture. Consistence reflects the strength and nature of the forces of attraction within a soil mass. The terms used in this report in describing soils are:

loose: noncoherent;

friable: (specifies friable when moist) soil material crushes easily under gentle to moderate pressure between thumb and forefinger, and coheres when pressed together;

firm: (specifies firm when moist) soil material crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable;

hard: (specifies hard when dry) moderately resistant to pressure, can be broken in the hands without difficulty, but is rarely breakable between thumb and forefinger;

compact: denotes a combination of firm consistence and a close packing or arrangement of particles;

plastic: (specifies plastic when wet) soil material can be formed into wires by rolling between the thumb and forefinger and moderate pressure is required for deformation of the soil mass.

7.3.3 Soil Moisture Classes

Soil moisture classes are defined according to: (1) actual moisture content in excess of field moisture capacity, and (2) the extent of the period during which such excess water is present in the plant root zone. The classes are:

rapidly drained: soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions;

well-drained: soil moisture content does not normally exceed field capacity in any horizon, except possibly the C, for a significant part of the year;

moderately well-drained: soil moisture in excess of field capacity remains for a short, but significant period during the year;

imperfectly drained: soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year;

poorly drained: soil moisture in excess of field capacity remains in all horizons for a significant part of the year;

very poorly drained: free water remains at or within 30 cm of the surface most of the year.

Special reference to surface drainage may be designated in terms of runoff and described as high, medium, low, or ponded. Similarly, specific references to the characteristics of horizons within the profile may be designated in terms of permeability or percolation and described as rapid, moderate, slow, very slow, or none.

7.3.4 Calcareous Classes

The Canada Soil Survey Committee (1978) has set the following nomenclature and limits for calcareous grades:

weakly calcareous:	1 to 5% calcium carbonate equivalent;
moderately calcareous:	6 to 15% calcium carbonate equivalent;
strongly calcareous:	16 to 25% calcium carbonate equivalent;
very strongly calcareous:	26 to 40% calcium carbonate equivalent;
extremely calcareous:	greater than 40% calcium carbonate equivalent;

7.3.5 Reaction Classes

The reaction classes and terminology adopted by the Canada Soil Survey Committee (1978) are:

Class	pH (H_2O)
extremely acid	less than 4.5
very strongly acid	4.5 to 5.0
strongly acid	5.1 to 5.5
medium acid	5.6 to 6.0
slightly acid	6.1 to 6.5
neutral	6.6 to 7.3
mildly alkaline	7.4 to 7.8
moderately alkaline	7.9 to 8.4
strongly alkaline	8.5 to 9.0
very strongly alkaline	greater than 9.0

7.3.6 Stoniness

The classes of stoniness are:

Stones 1: (slightly stony land) some stones, offering slight to no hindrance to cultivation;

Stones 2: (moderately stony land) enough stones to intefere somewhat with cultivation;

Stones 3: (very stony land) enough stones to constitute a serious handicap to cultivation and to require some clearing;

Stones 4: (exceedingly stony land) enough stones to prevent cultivation until considerable clearing is done (50 to 90% stones by volume);

Stones 5: (excessively stony land) the land is a boulder or stone pavement, too stony to permit any cultivation (greater than 90% stones by volume).

7.3.7 Horizon Boundaries

The lower boundary of each horizon is described by indicating its distinctness and form as suggested in the United States Department of Agriculture (USDA) Soil Survey Manual (USDA 1951). The classes of distinctness are:

abrupt	less than 2.5 cm wide
clear	2.5 to 6.25 cm wide
gradual	6.25 to 12.5 cm wide
diffuse	more than 12.5 cm wide

The categories for form are:

smooth	nearly a plane
wavy	pockets are more wide than deep
irregular	pockets are more deep than wide
broken	parts of the horizon are unconnected with other parts

7.3.8 Roots

The terminology for describing roots is that adopted by the Canada Soil Survey Committee (1974). In this system both the abundance and diameter of roots are described. The classes of abundance are:

Abundance Category	Number of Roots per Unit Area (2.5 cm^2 of Surface)
very few	less than 1
few	1 to 3
plentiful	4 to 14
abundant	more than 14

Diameter Category	Diameter of Roots
micro	less than 0.075 mm
very fine	0.075 to 1 mm
fine	1 to 2 mm
medium	2 to 5 mm
coarse	more than 5 mm

7.4 GLOSSARY OF TERMS

This is included to define terms commonly used in the report; it is not a comprehensive soil glossary.

acid soil - a soil having a pH of less than 7.0

aeration - the process by which air in the soil is replaced by air from the atmosphere

aggregate - a group of soil particles cohering so as to behave mechanically as a unit

alkali soil - a soil having a pH greater than 8.5 or an exchangeable sodium percentage greater than 15

alluvial deposit (Alluvium) - material deposited by moving water

aspect - orientation of the land surface with respect to compass direction

available plant nutrients - that portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants

bedrock - the solid rock and the unconsolidated mantle of weathered rock that underlies the soil or that is exposed at the surface

bulk density, soil - the mass of dry soil per unit bulk volume

cation - an ion carrying a positive charge of electricity. The most common soil cations are calcium, magnesium, sodium, potassium, and hydrogen

cation exchange capacity (CEC) - a measure of the total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 g of soil

coarse fragments - rock or mineral particles greater than 2 mm in diameter

clod - a compact, coherent mass of soil produced by digging or plowing

colluvium - a heterogeneous mixture of material that has been deposited mainly by gravitational action

concretion - a local concentration of a chemical compound, such as calcium carbonate or iron oxide, in the form of a grain or nodule of varying size, shape, hardnes, and colour

consistence - (a) the resistance of a material to deformation or rupture, (b) the degree of cohesion or adhesion of the soil mass

control section - the vertical section upon which soil classification is based

creep - slow mass movement of soil material down rather steep slopes primarily under the influence of gravity, but aided by saturation with water and alternate freezing and thawing

drift - all material moved by glaciers and by the action of meltwater streams and associated lakes

droughty soil - sandy or very rapidly drained soil

eluviation - the removal of soil material in suspension or in solution from a layer or layers of the soil

engineering tests - laboratory tests made to determine the physical properties of soils that affect their uses for various types of engineering construction

eolian deposit - material deposited by wind, including both loess and dune sand

erosion - the wearing away of the land surface by running water, wind, or other erosive agents. Erosion may be either normal or accelerated; the latter being brought about by changes in the natural cover or ground conditions, including those due to human activity

fertility - the status of a soil in relation to the amount and availability to plants of elements necessary for growth

MAPS NOT FILMED

CARTES OMISES